



# SAN MATEO CREEK BASIN GROUND WATER STUDY

GRANTS MINING DISTRICT  
NEW MEXICO

Monthly RPM Meeting  
November 14, 2017

# Legacy of Uranium Mining in Northwestern New Mexico



- Uranium Mine
- ▲ Mill Location
- City or Town
- ▭ Uranium Sub-District
- ▭ Pueblo of Acoma
- ▭ Pueblo of Laguna
- ▭ Navajo Nation Chapter
- ▭ Navajo Nation Ownership
- ▭ San Mateo Basin
- ▭ NPL Site
- ▭ County
- Land Ownership for Tracts with Mines
- ▭ Bureau of Land Management
- ▭ Forest Service
- ▭ Tribal Land
- ▭ Private Land
- ▭ State Land

Note:  
The Land Ownership layer as displayed is not complete.  
The only areas displayed are those containing one or more mines.

Sources:  
MMD Legacy Uranium Mine Inventory: 12/2008.  
EPA Region 6 National Priorities List (NPL), 5/2015.  
Bureau of Land Management (BLM) Land Ownership.  
Navajo Land Department 2016, Census Bureau 2000  
TIGER/Line, ESRI World Shaded Relief.

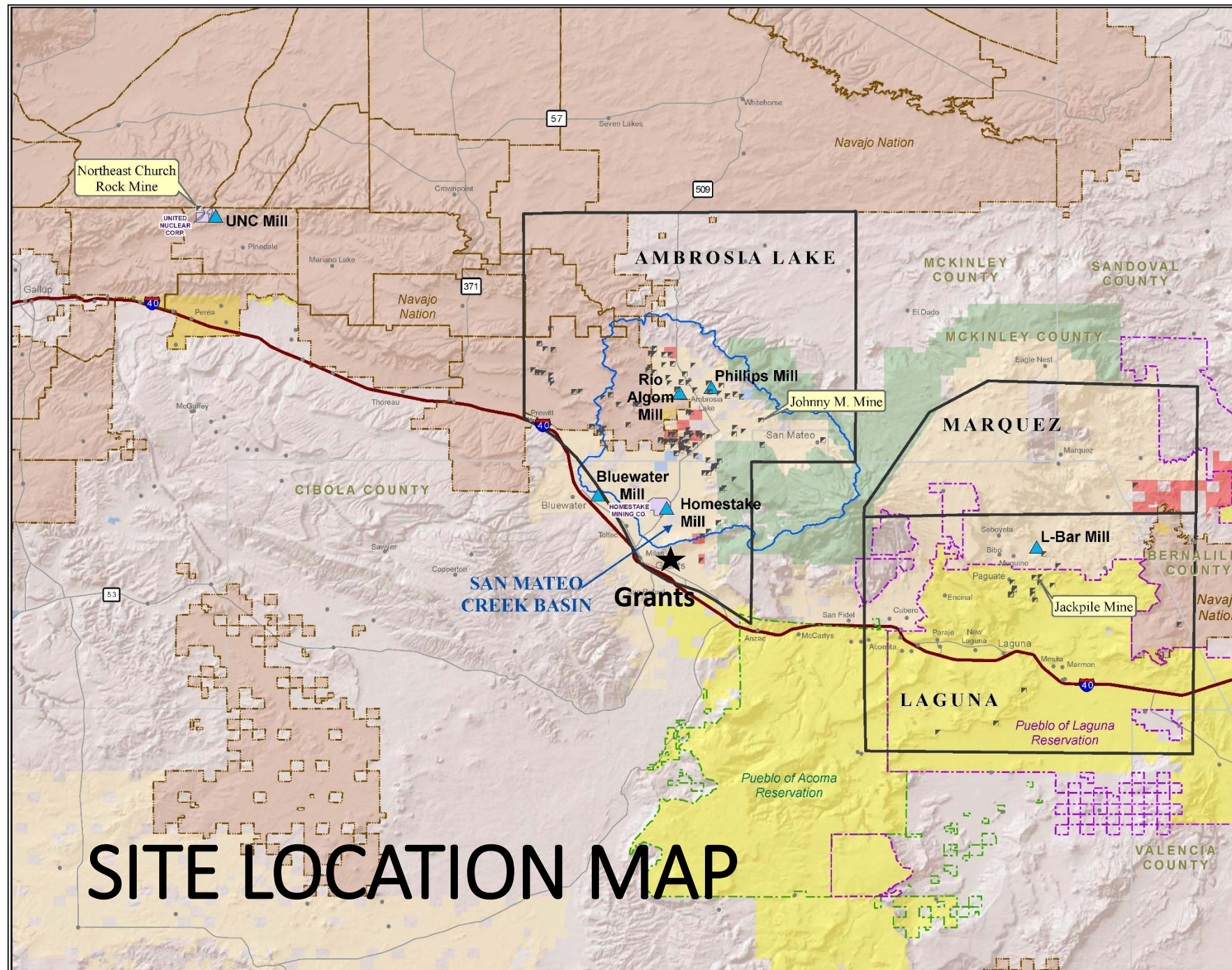


EPA Region 6  
Superfund  
GIS Support  
04/25/2016

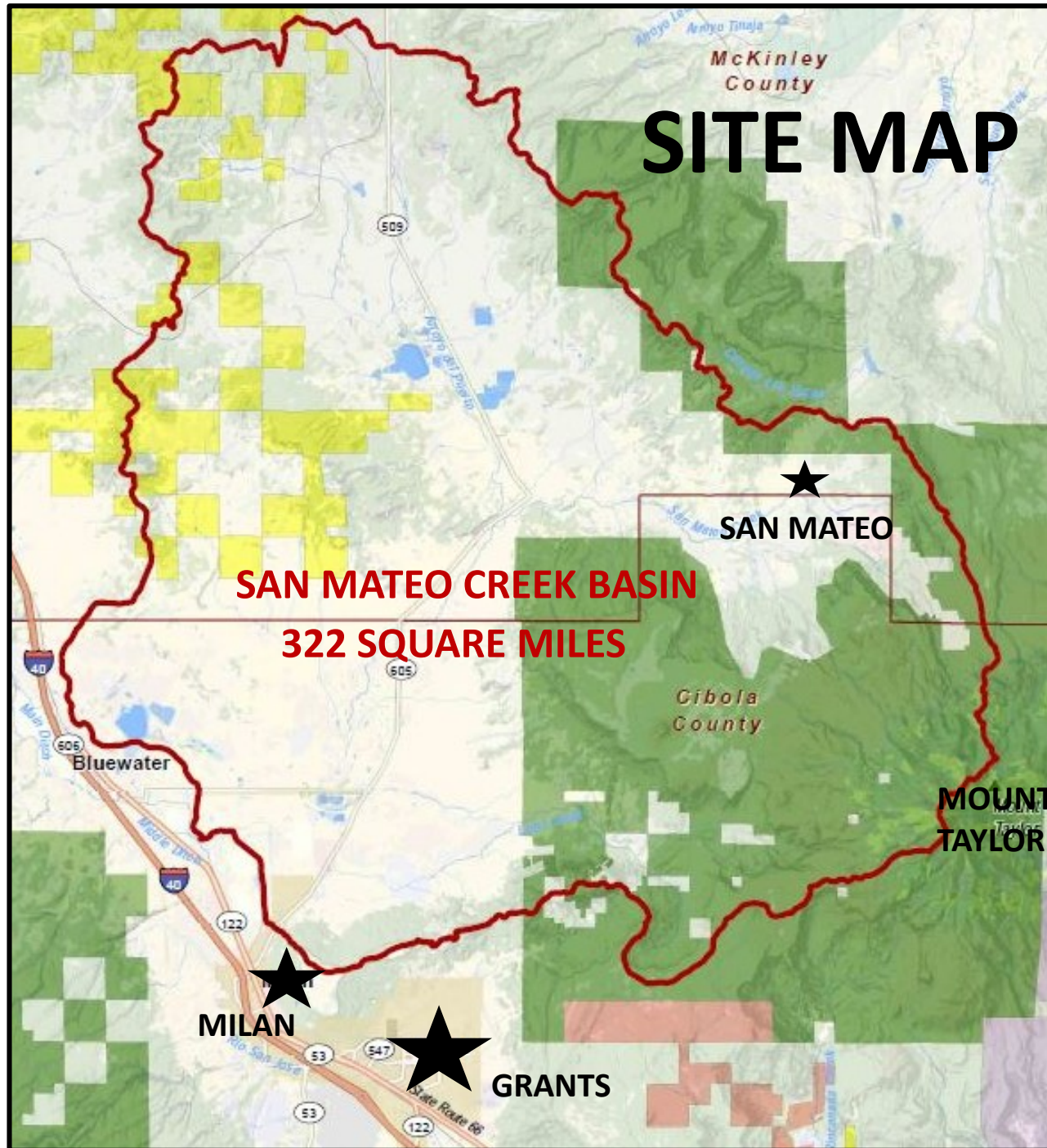


20160425ML01

## SITE LOCATION MAP









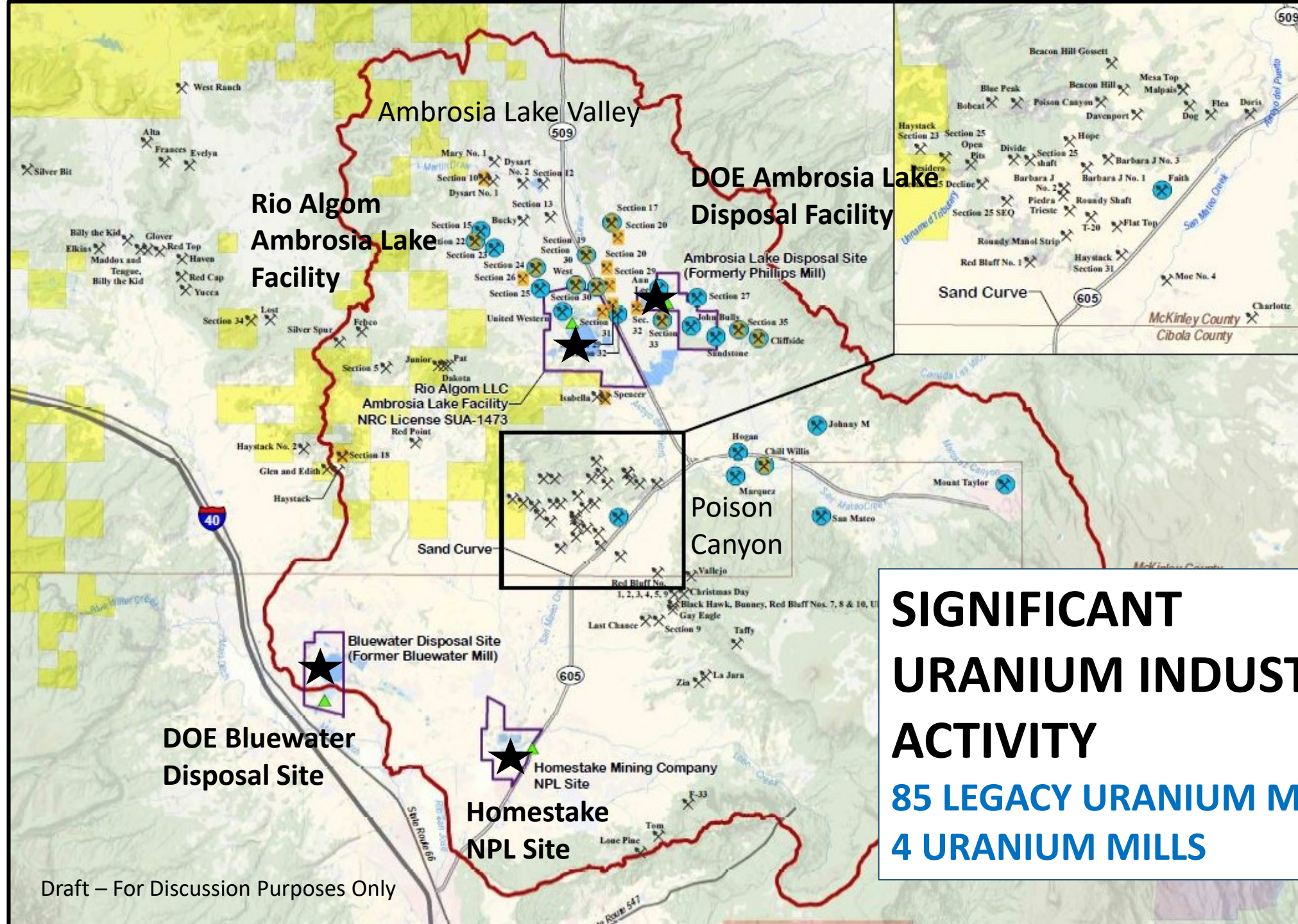


**Mount Taylor**

## LEGEND

-  Navajo Land
-  Forest Service Land
-  Acoma Pueblo Land
-  Laguna Pueblo Land

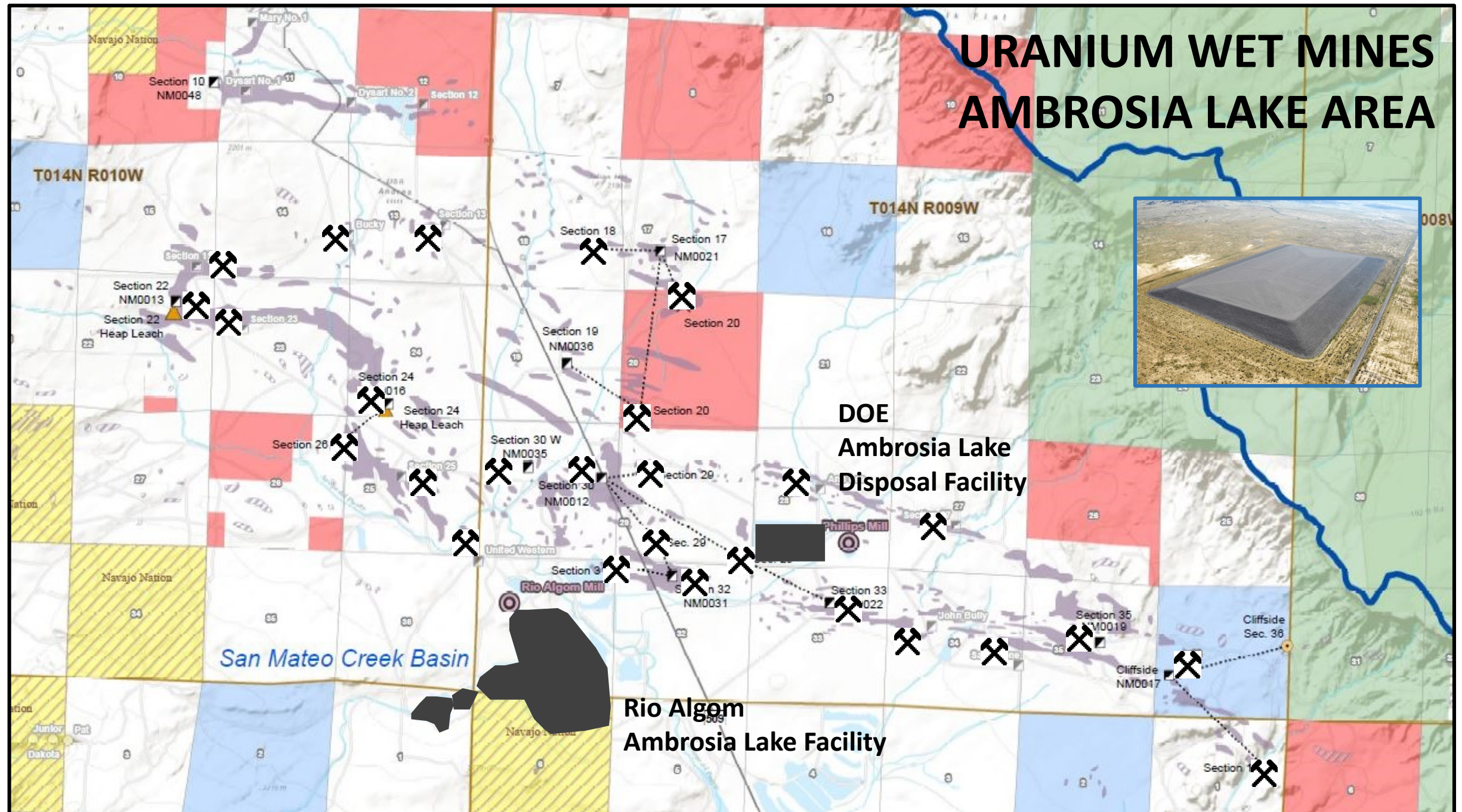




**SIGNIFICANT  
URANIUM INDUSTRY  
ACTIVITY**  
**85 LEGACY URANIUM MINES**  
**4 URANIUM MILLS**



# URANIUM WET MINES AMBROSIA LAKE AREA

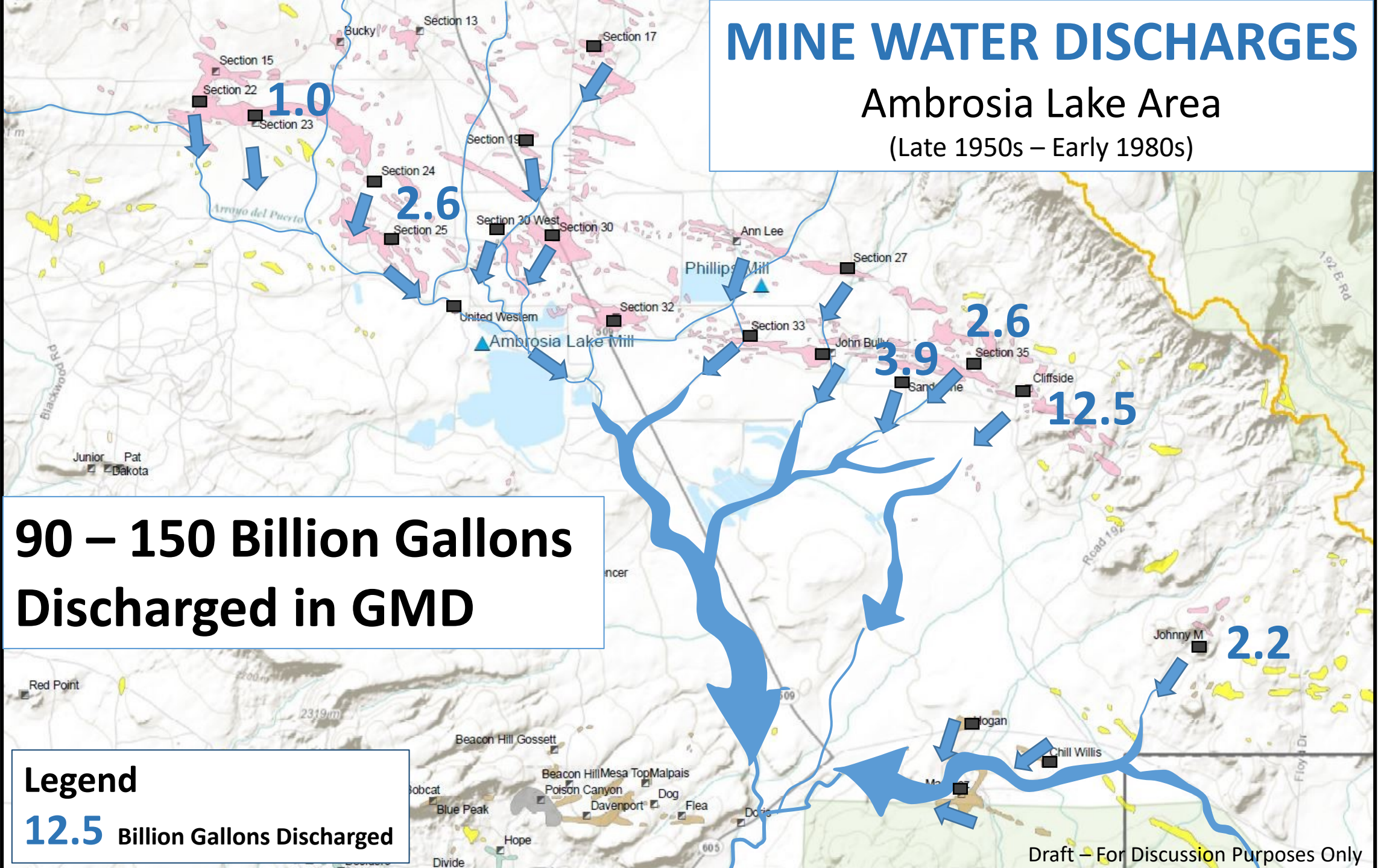




# MINE WATER DISCHARGES

## Ambrosia Lake Area

(Late 1950s – Early 1980s)

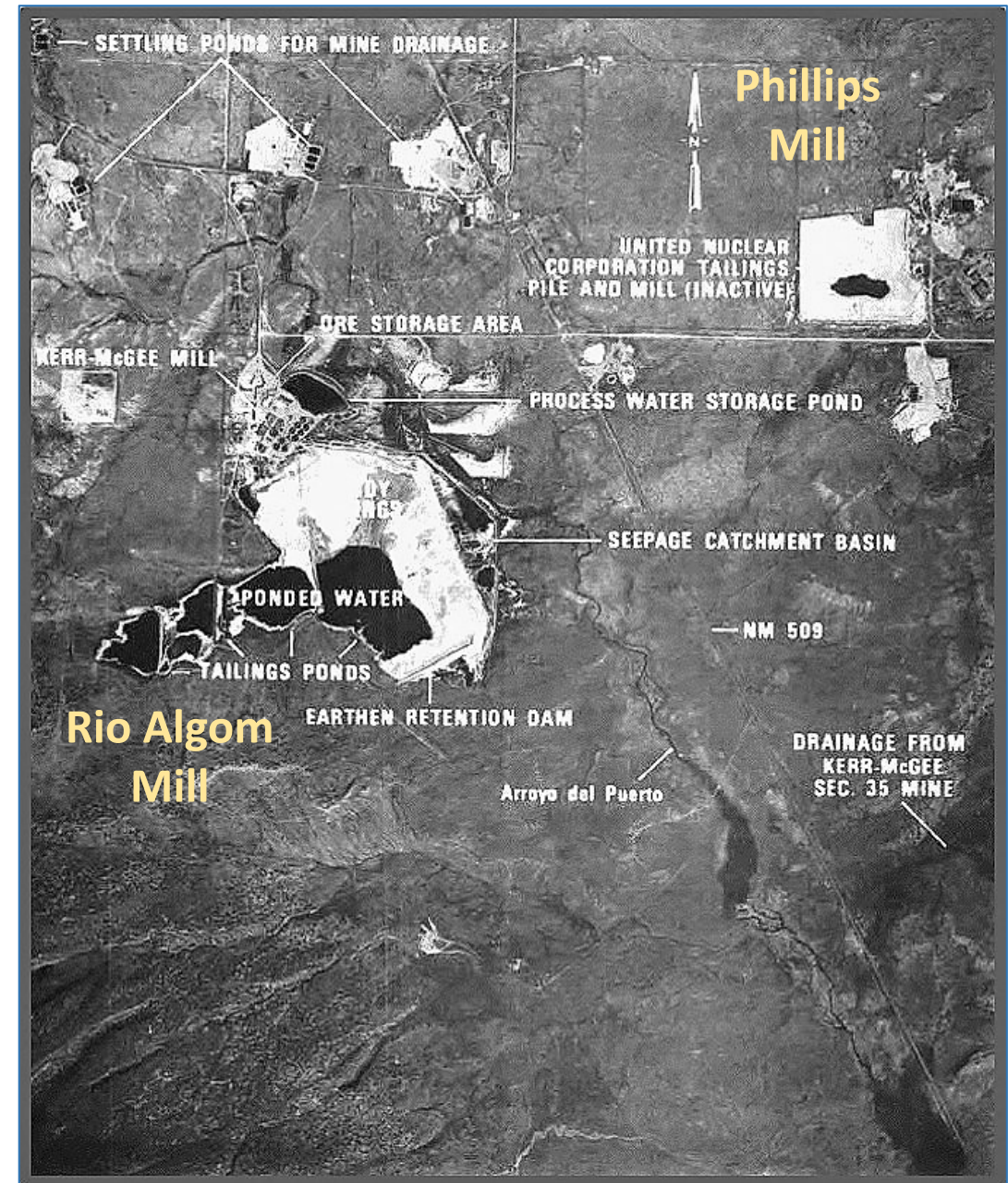


90 – 150 Billion Gallons  
Discharged in GMD



# URANIUM MINING INDUSTRY IMPACTS GROUND WATER

- 1975 EPA Assessment Identifies Ground Water Contamination
- Mine Water Discharge Creates Perennial Flows
- Alluvial GW Quality Standards Exceeded (New Mexico 1986)



1975 – Ambrosia Lake Area



# MINE WATER DISCHARGE

Artificially  
Created  
Perennial Flows  
Observed to  
Reached  
Homestake  
Impoundment  
(EPA 1980)

## ROUNDY RANCH

Built Spreader Dams to  
Capture Flow for Cattle  
Forage

HOMESTAKE NPL SITE

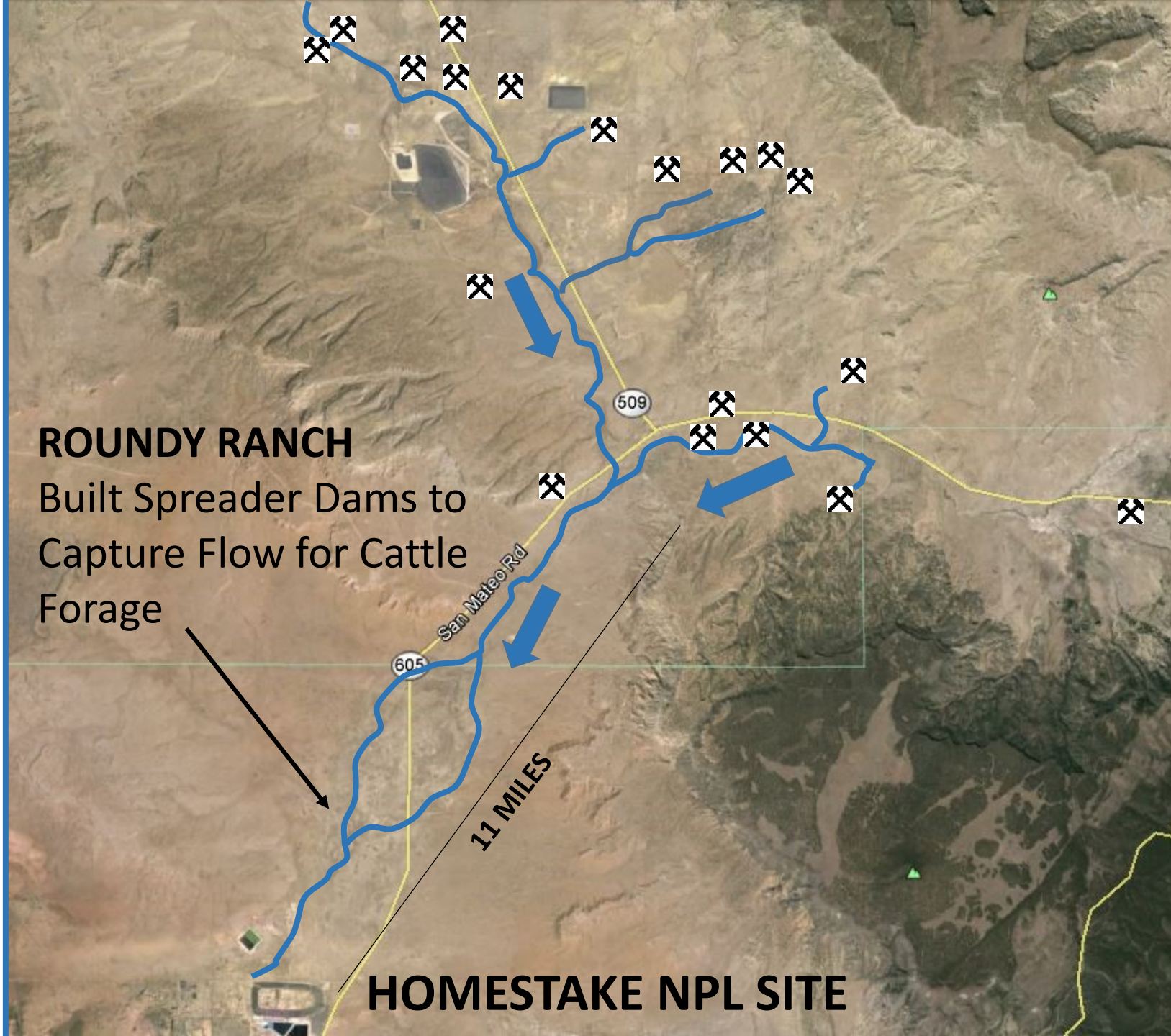
11 MILES

San Mateo Rd

509

605

WET MINE





# SUMMARY OF HISTORIC MINE WATER DISCHARGE QUALITY

## And Comparison to Alluvial Background Water Quality

Contaminant	1981 Mine Water Discharge Ambrosia Lake Area	1981 Mine Water Discharge San Mateo Area	1978-80 San Mateo Creek Upland Alluvial GW (Background)
Gross Alpha (pCi/L)	580	1,100	2.5 – 15.0
Uranium (mg/L)	2.4	0.080	0.005 – 0.010
Selenium (mg/L)	0.410	0.040	0.005 – 0.005
Molybdenum (mg/L)	0.79	0.32	0.005 – 0.010
Chloride (mg/L)	90	10	3 – 8
Sulfate (mg/L)	837	205	5-20
Total Dissolved Solid (ppm)	1,690	520	125 – 300

New Mexico 1981 and 1986 Reports

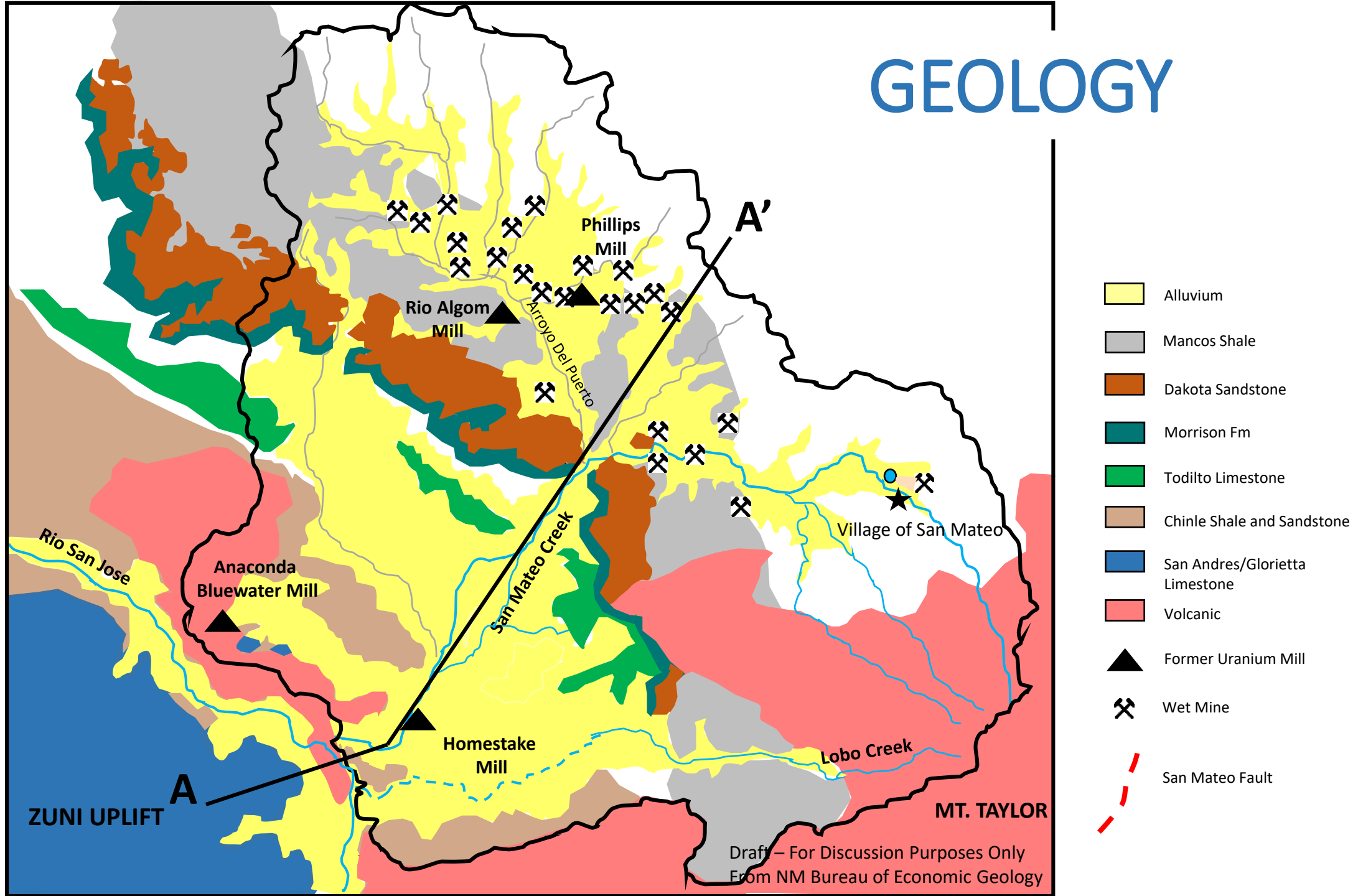


# STUDY OBJECTIVE

- ASSESS GROUND WATER IMPACTS FROM MASSIVE SLUG OF MINE DISCHARGE WATER TO BASIN
  - Quaternary Alluvial Aquifer
  - Multiple Bedrock Aquifers



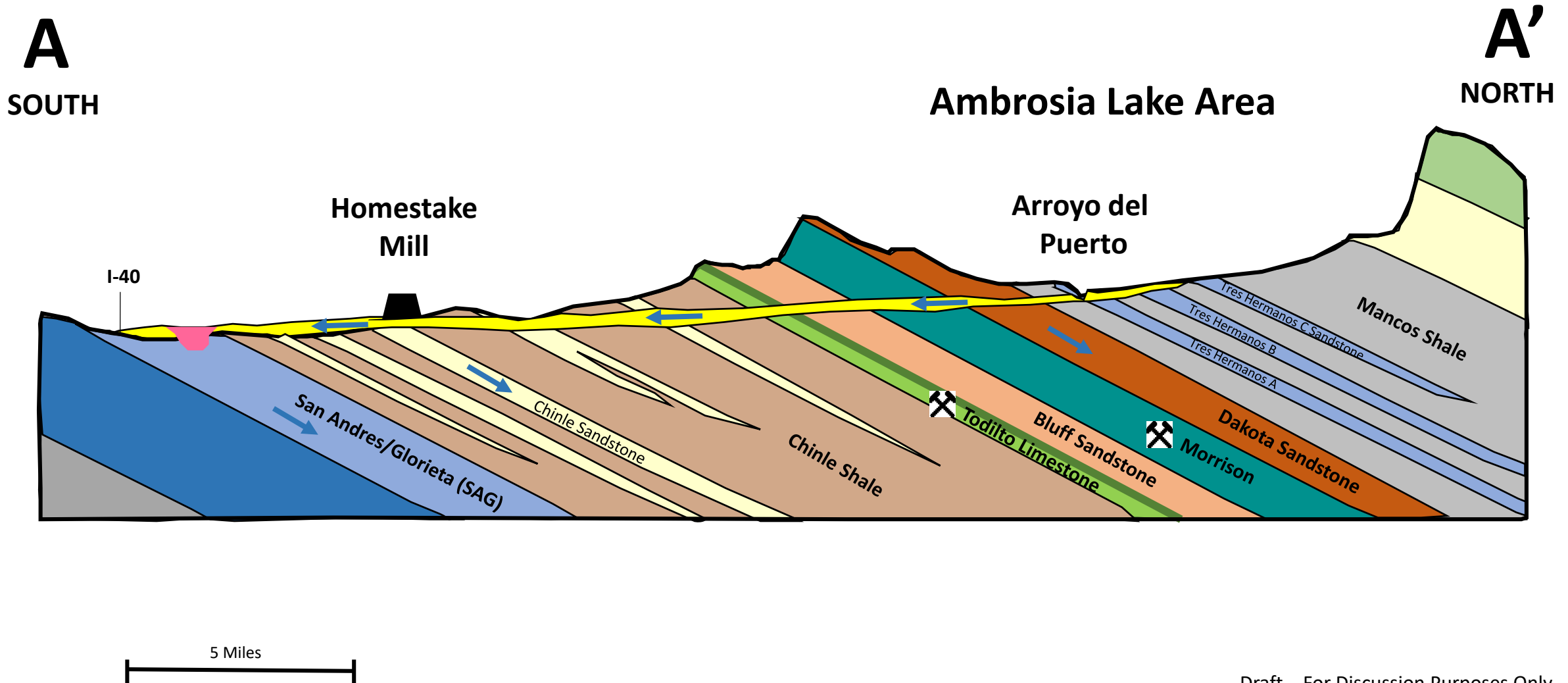
# GEOLOGY





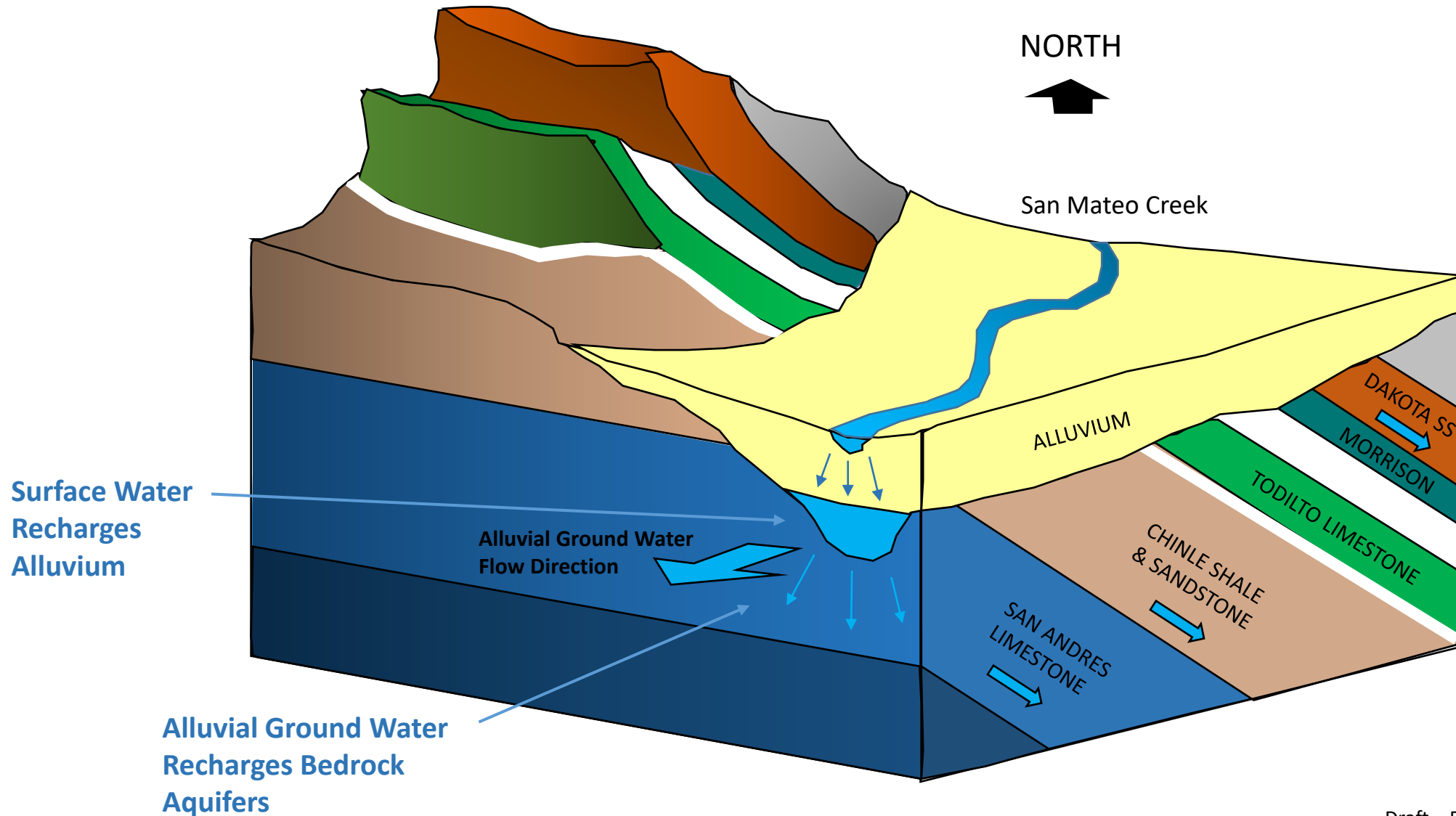
# CONCEPTUAL SITE GROUND WATER MODEL

## Generalized Cross Section Through San Mateo Creek Basin





# CONCEPTUAL SITE GROUND WATER MODEL





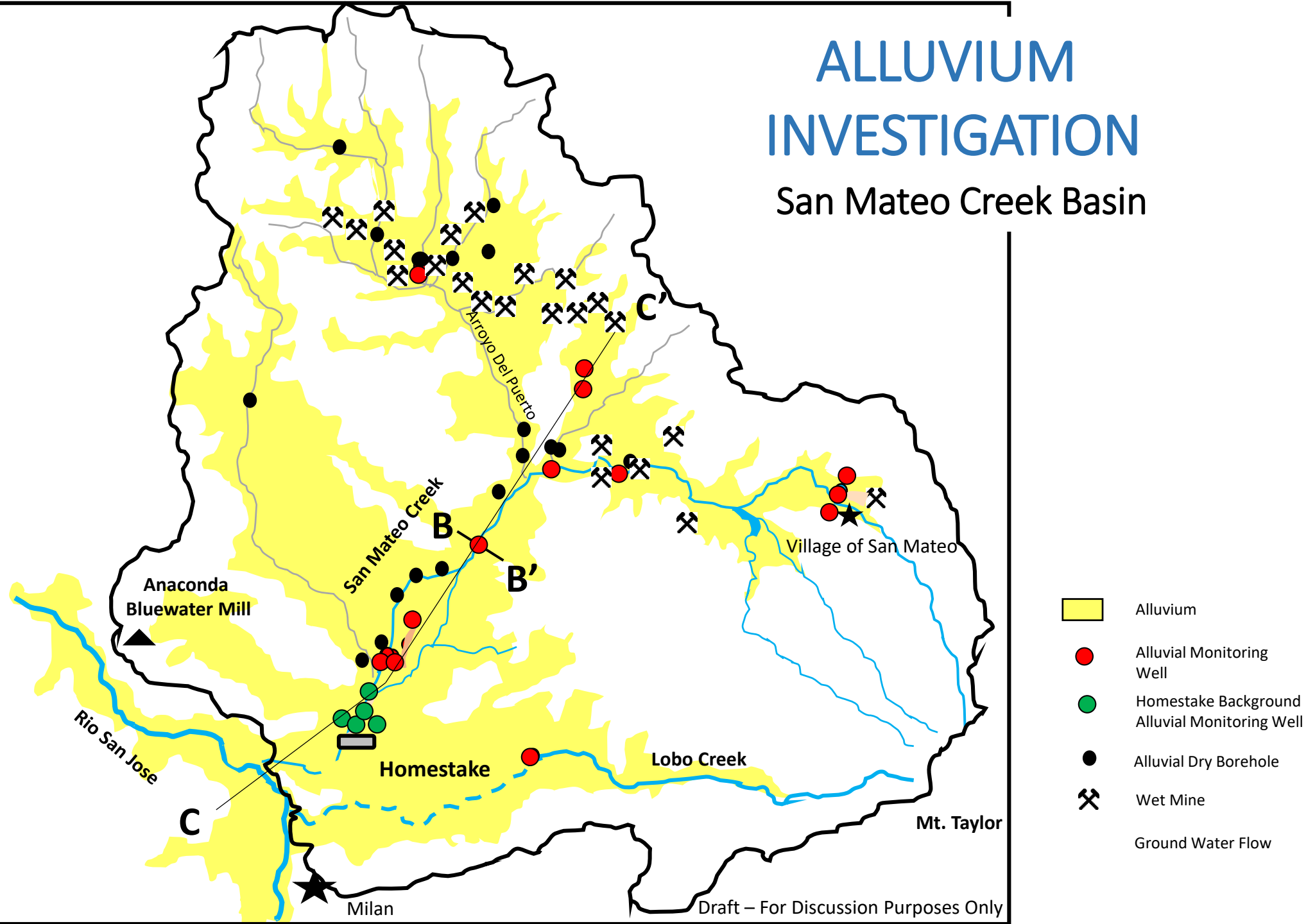
# VIEW OF TILTED BEDROCK FORMATIONS

## San Mateo Creek Basin



# ALLUVIUM INVESTIGATION

## San Mateo Creek Basin





**CROSS SECTION A - A'**  
**CENTRAL SAN MATEO CREEK BASIN AREA**

**B**

West

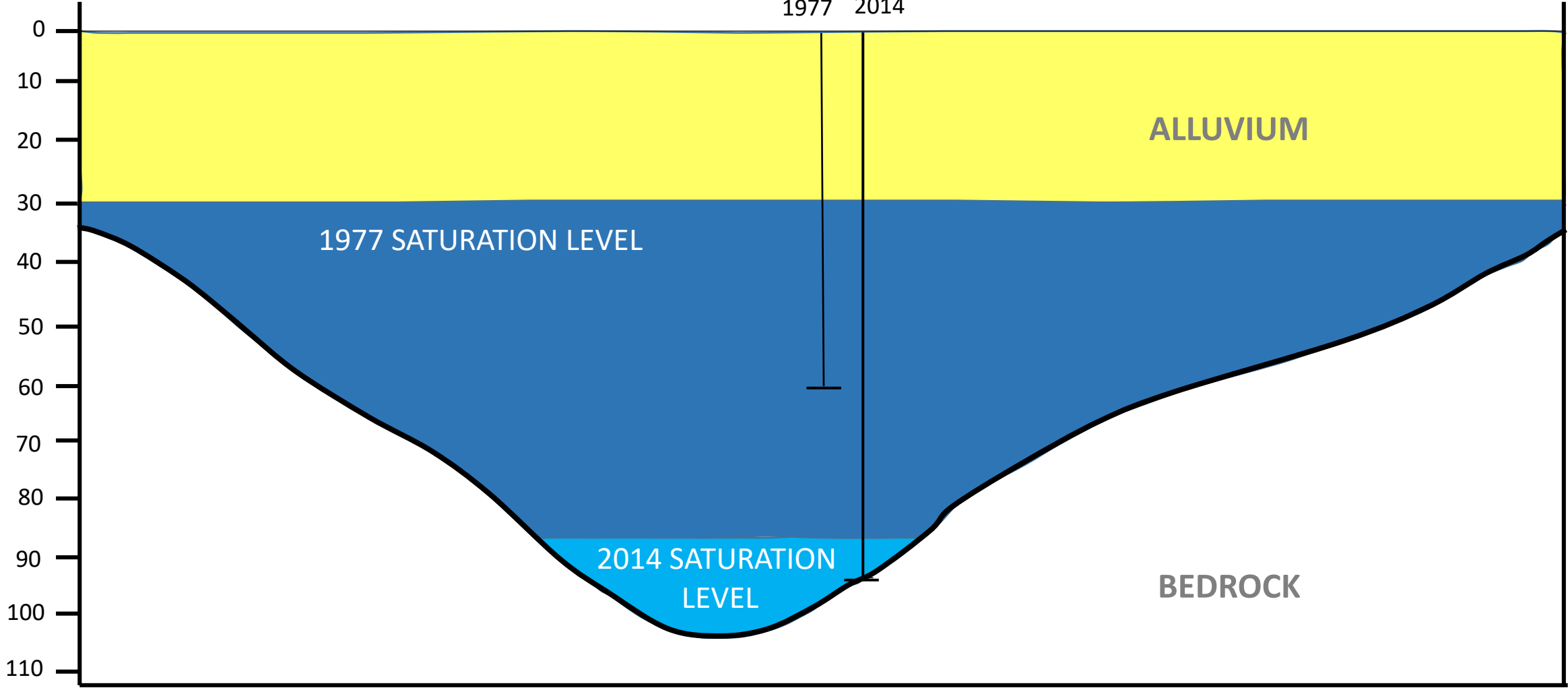
**B'**

East

Depth  
(ft)

NMED  
Monitoring  
Well  
1977

EPA Well  
C-3  
2014



## C'

NOF













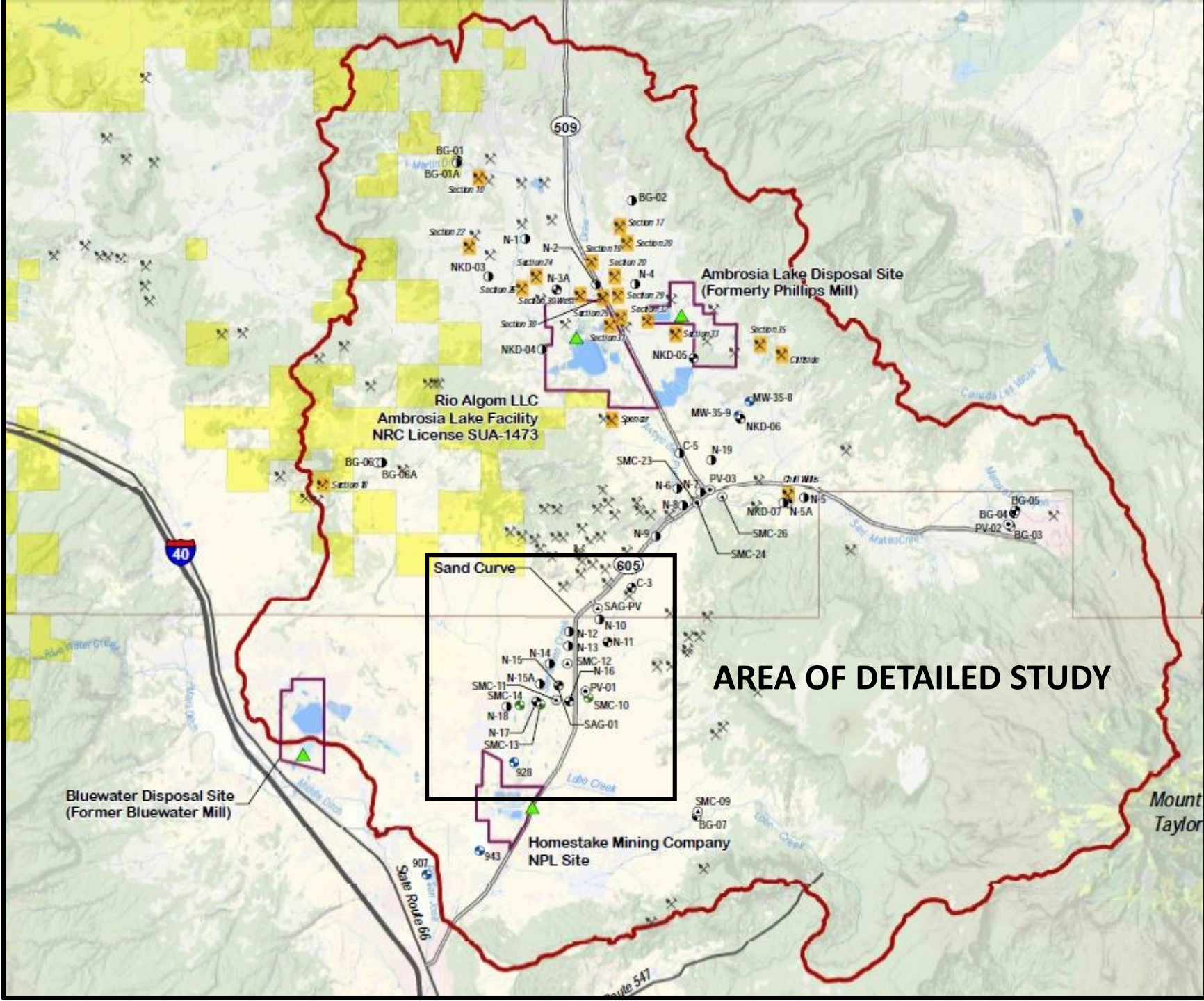








# LOWER SAN MATEO CREEK BASIN



# LEGACY MINE DISCHARGE WATER IMPACTS ANALYSIS FOR LOWER BASIN

- MAP CHANGES IN WATER LEVELS OVER TIME
  - Identify Physical Presence of Mine Discharge Water
- MAP CHANGES IN WATER QUALITY OVER TIME
  - Plume Maps for Key Constituents
- CONSTRUCT TEMPORAL PLOTS OF CONSTITUENT CONCENTRATIONS
  - Look for Upward Trends



# ALLUVIAL GROUND WATER FLOW 1956-61

**LEGEND**

- EPA Monitoring Well
- Private Monitoring Well
- Industry Monitoring Well
- Private Livestock Well
- NRC License Boundary (Approximate)
- Homestake Impoundment
- Evaporation Ponds
- Groundwater Flow Direction
- Groundwater Elevation Contour
- Boundary of Alluvial Aquifer
- Base of Alluvial Structure
- Contour 10-ft Interval
- Contour 50-ft Interval

**SMC-12**  
950  
Rounly

6589.3' — Groundwater Elevation in Feet  
(56) — Year(s) of groundwater level measurement

**NOTE:**  
1. Groundwater elevation in feet

**SEMS ID:** NMN000000047  
**TSD NO:** 0005/WE/STON/4042-17-025-001

**SOURCE:** U.S. Geological Survey, National Hydrography Dataset, San Mateo Creek Basin, New Mexico 2016

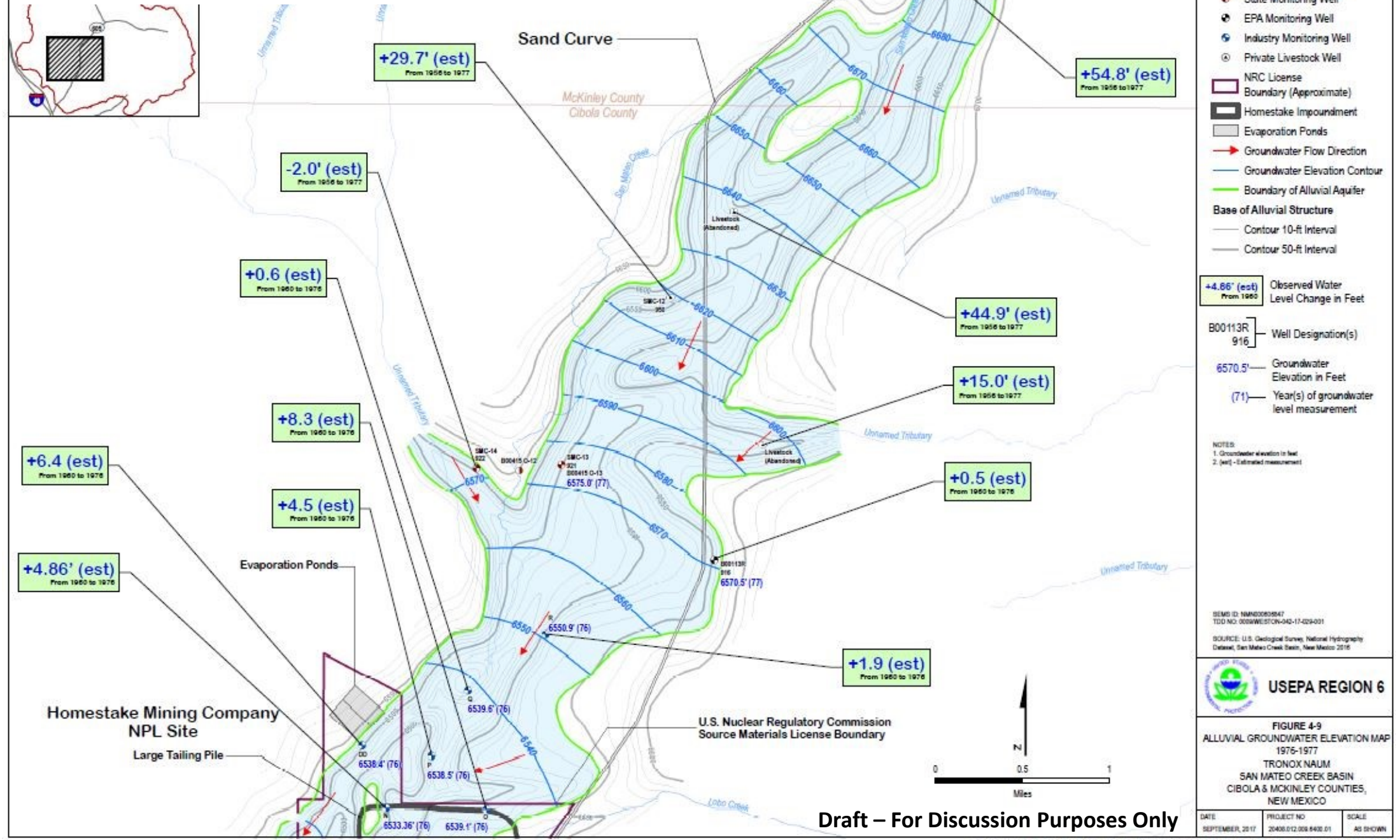
**USEPA REGION 6**

**FIGURE 4-8**  
**ALLUVIAL GROUNDWATER ELEVATION MAP**  
**1956-1961**  
**TRONOX NAUM**  
**SAN MATEO CREEK BASIN**  
**CIBOLA & MCKINLEY COUNTIES,**  
**NEW MEXICO**

**Draft - For Discussion Purposes Only**

**Draft – For Discussion Purposes Only**

# ALLUVIAL GROUND WATER FLOW 1977

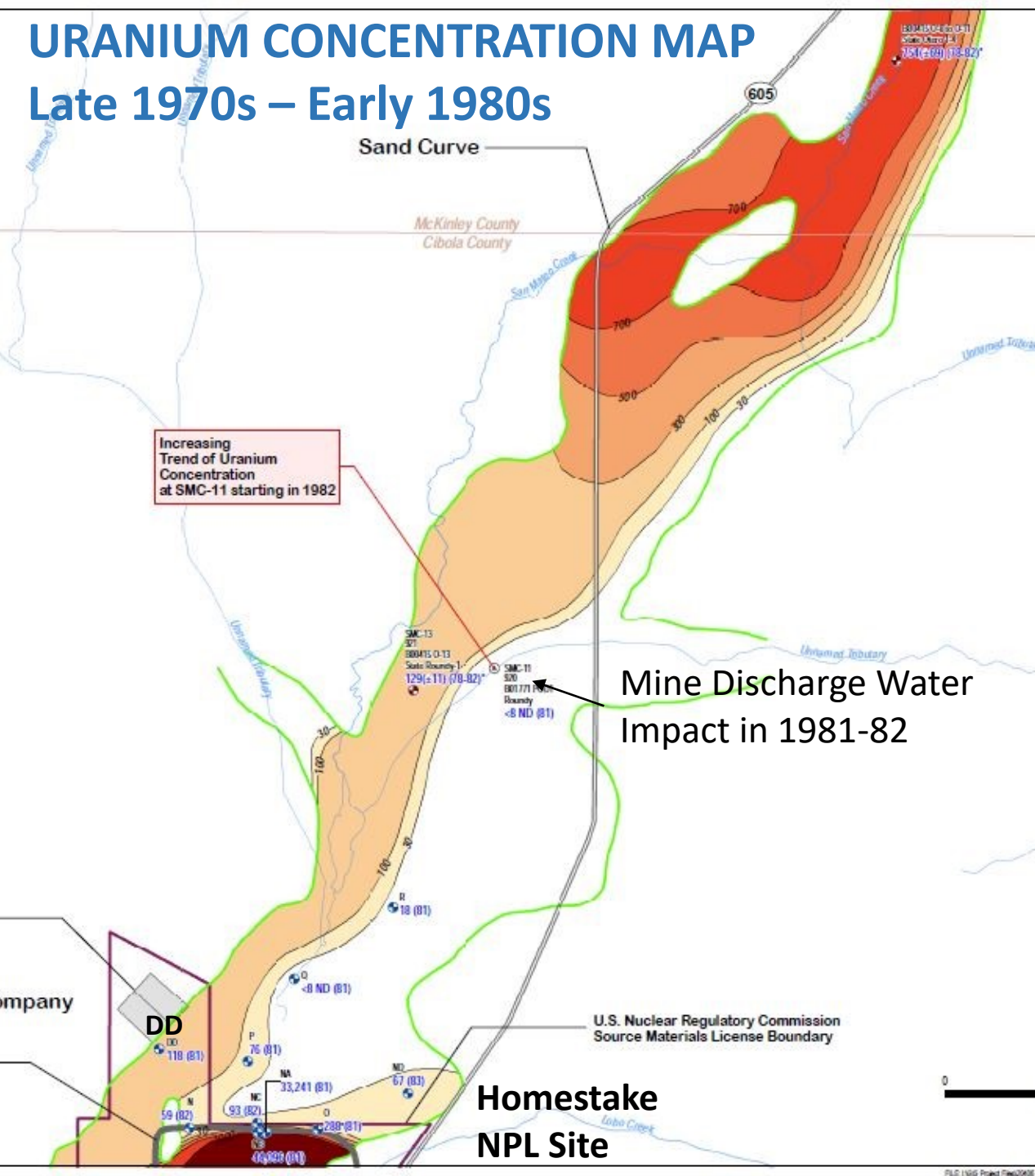






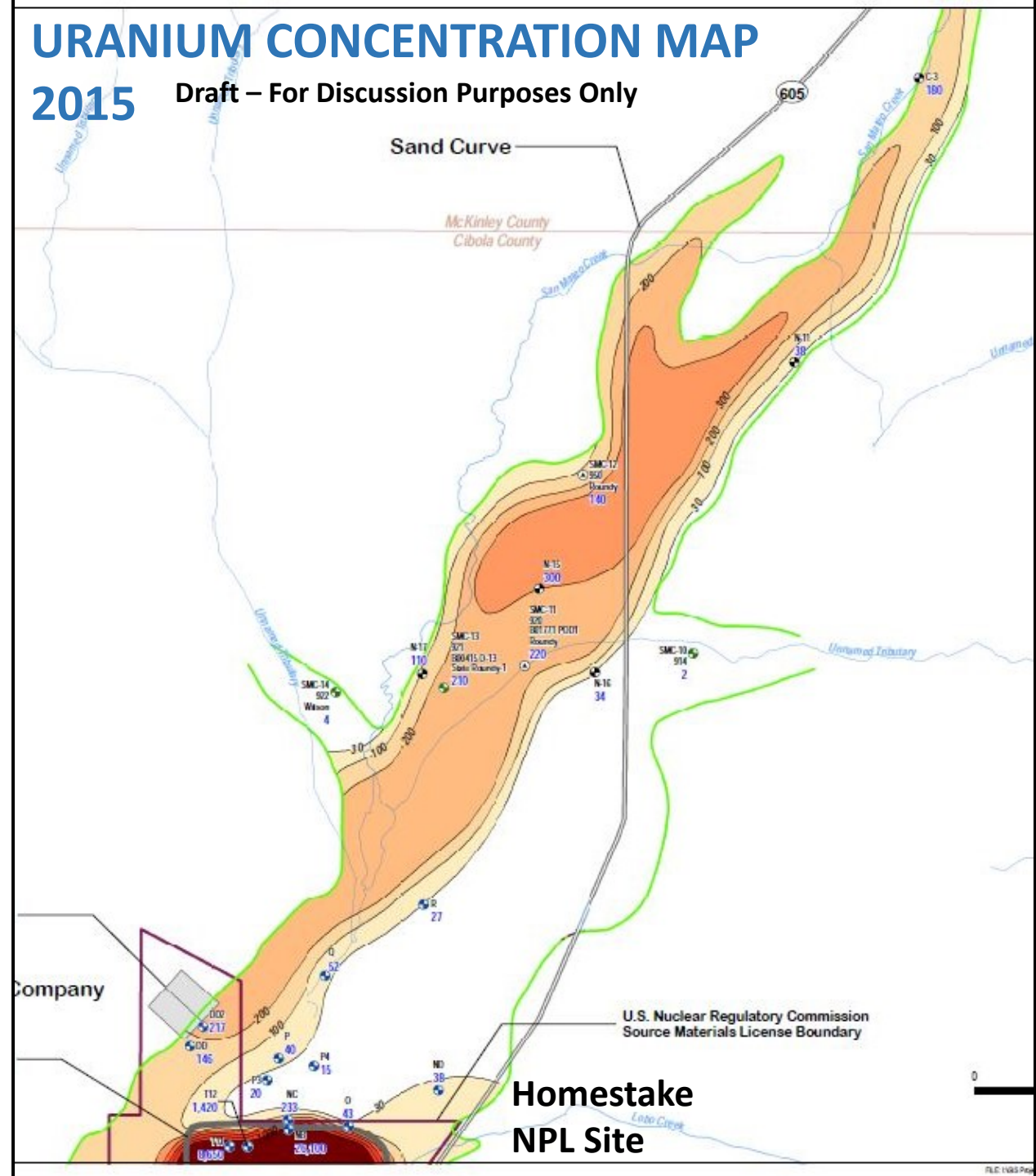
# URANIUM CONCENTRATION MAP

Late 1970s – Early 1980s



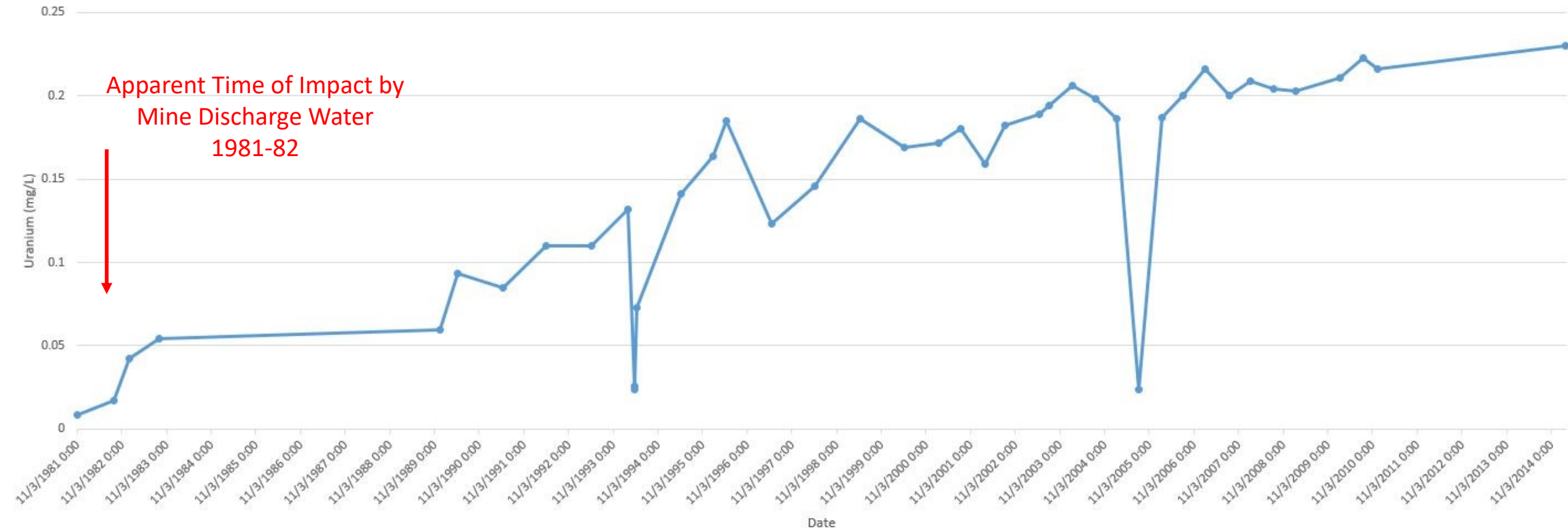
# URANIUM CONCENTRATION MAP

2015 Draft – For Discussion Purposes Only





# Homestake Well 920 (SMC-11) Uranium-Time Trend Plot

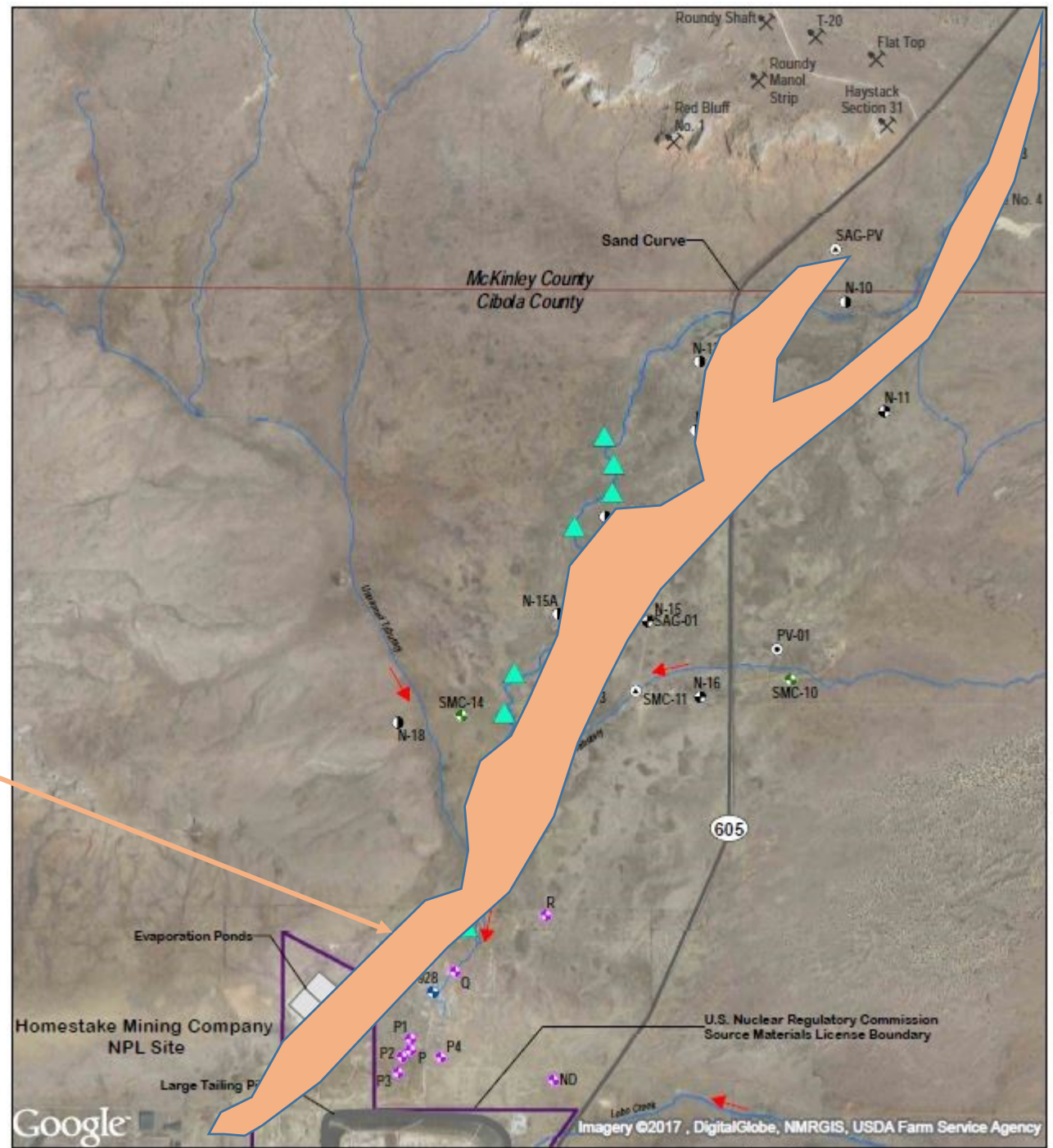


# POSSIBLE SURFACE WATER FLOW PATH FOR EARLY URANIUM

## ▲ SPREADER DAMS FOR CATTLE FORAGE

POSSIBLE EARLY  
MINE DISCHARGE WATER  
IMPACTS TO GROUND  
WATER FROM SURFACE  
WATER PATHWAY (PRE-  
1976)?

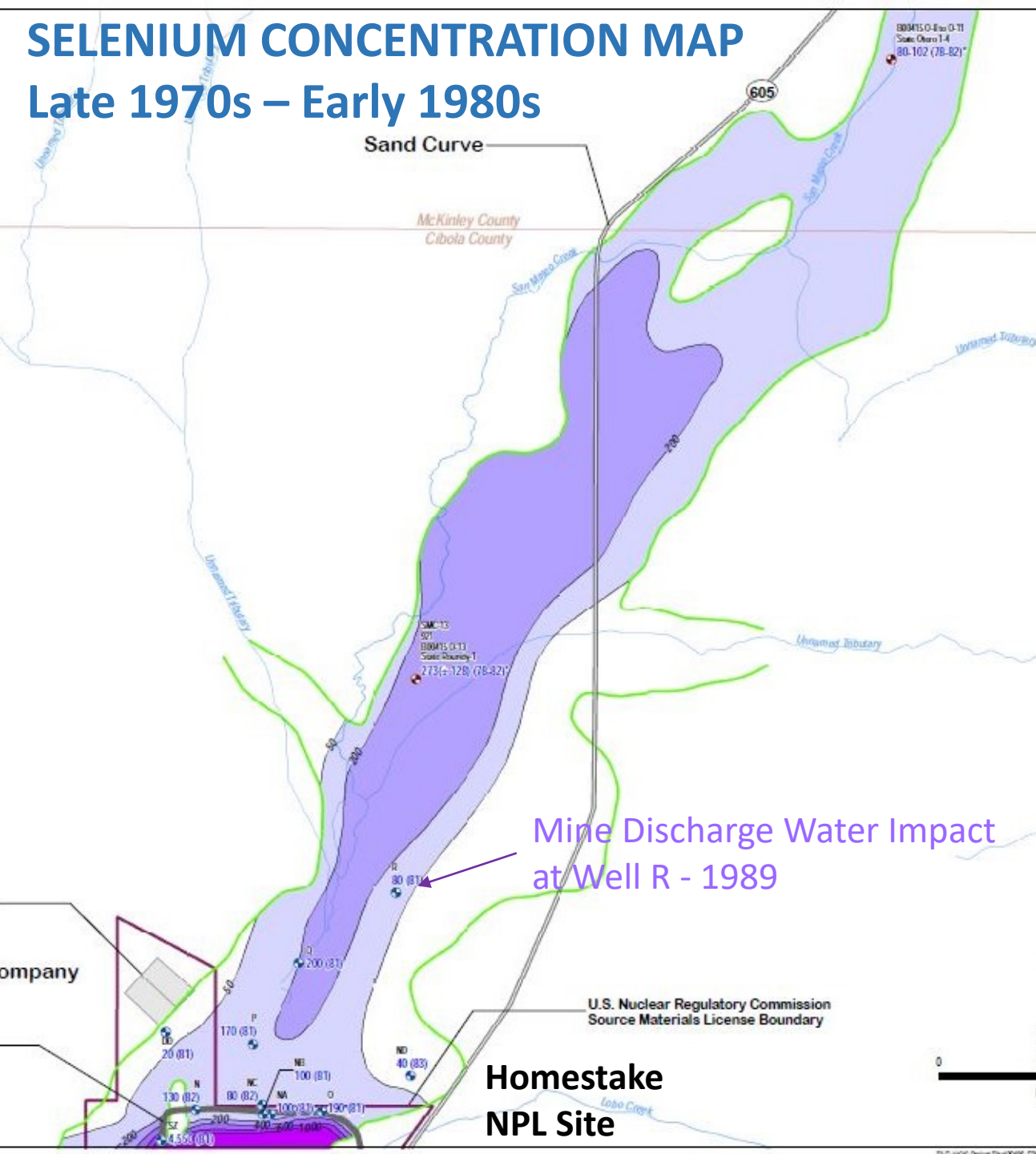
**Draft – For Discussion Purposes Only**





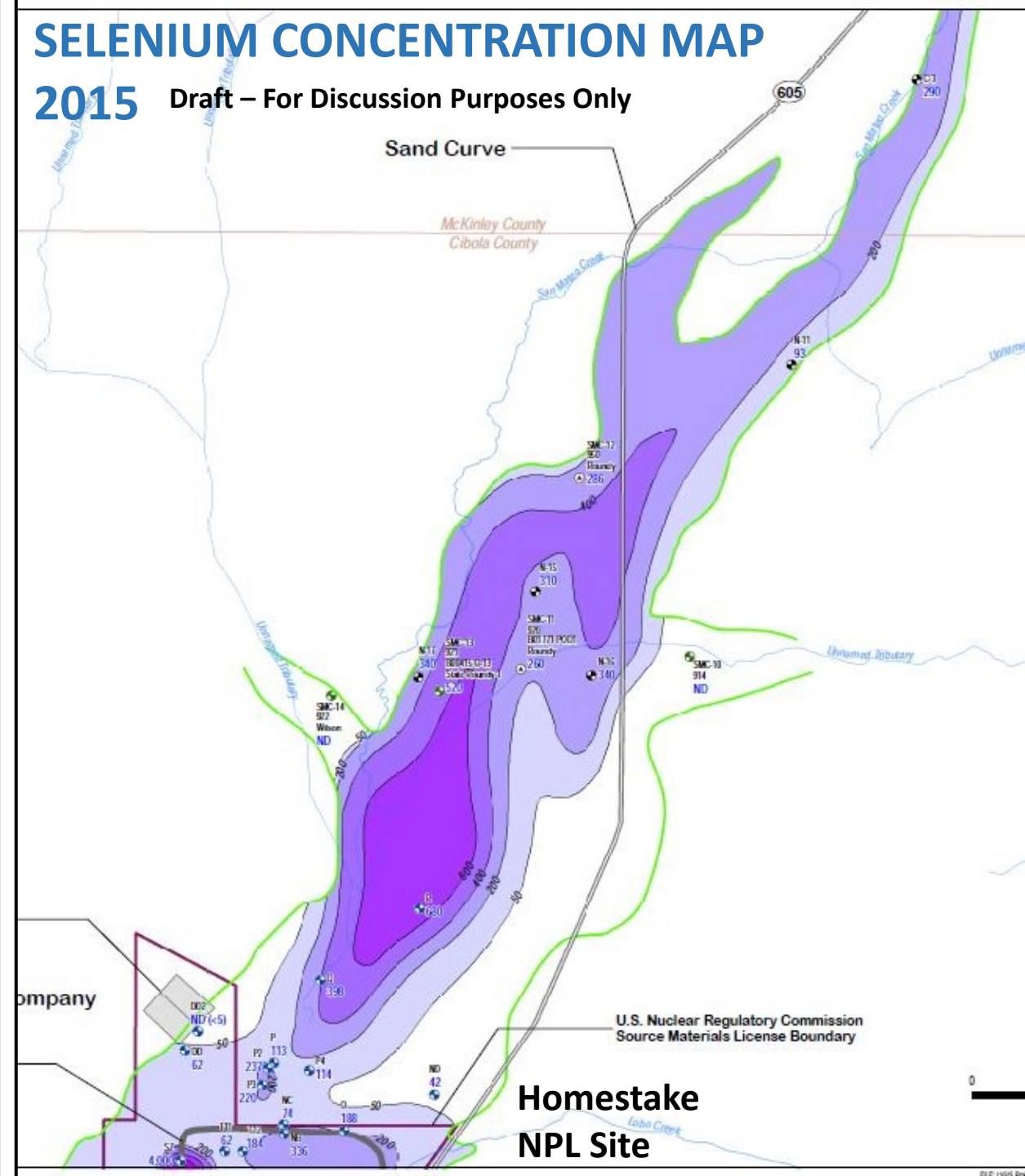
# SELENIUM CONCENTRATION MAP

Late 1970s – Early 1980s

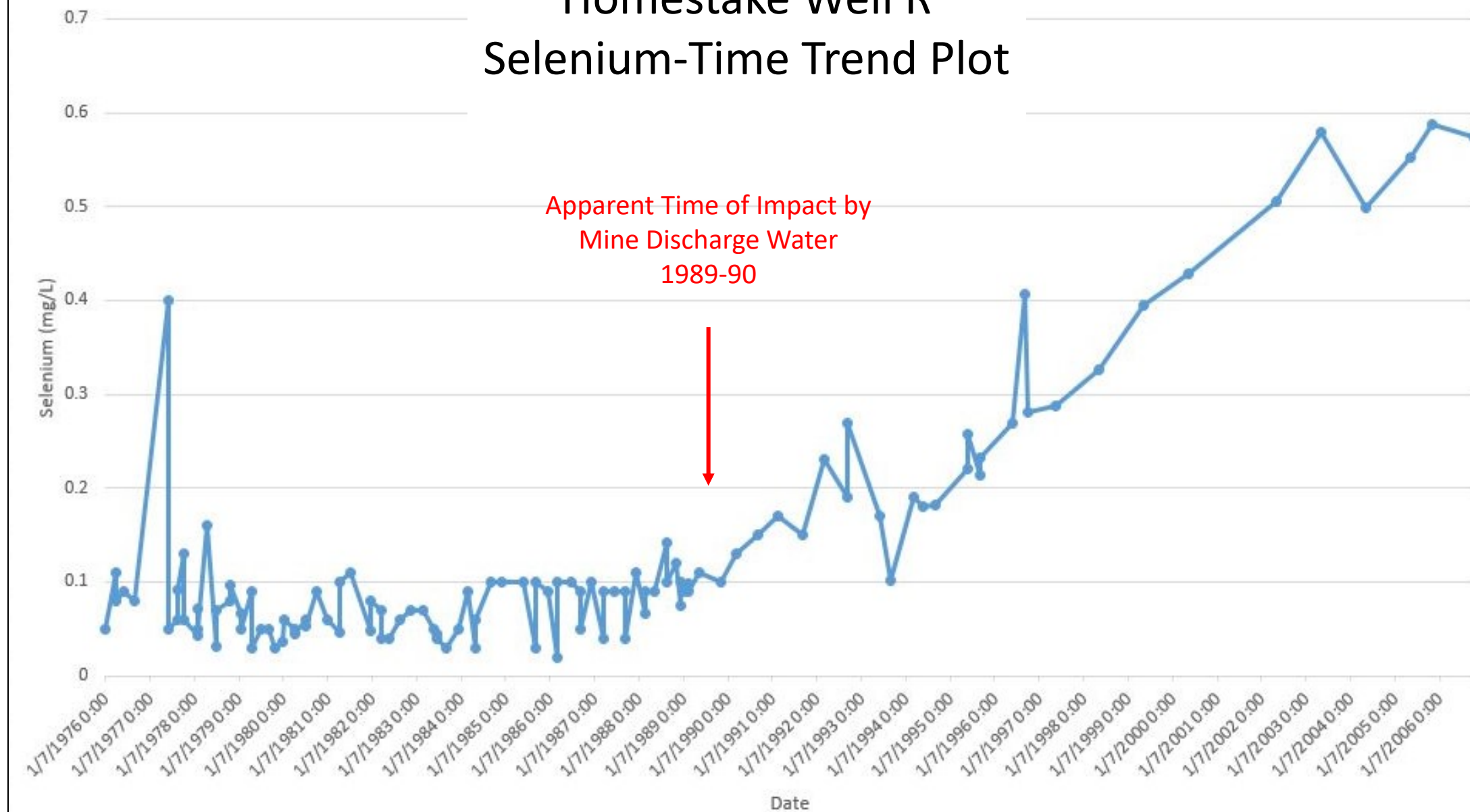


# SELENIUM CONCENTRATION MAP

2015 Draft – For Discussion Purposes Only



# Homestake Well R Selenium-Time Trend Plot





# GEOCHEMISTRY – ENVIRONMENTAL FORENSICS

- SYSTEMATIC INVESTIGATION OF WATER TYPES
  - Major Ions (Cations and Anions)
  - Trilinear Diagrams
    - Classify Water Ion Composition
  - Stiff Diagrams
    - Presents Ion Concentration Data as Graphic Shapes
  - Ion to Ion Relationships
  - Uranium Activity Ratios
  - Stable Isotopes – Oxygen, Hydrogen, Sulfur, Carbon
    - Use as Tracer or Fingerprint to Source
- MULTIPLE LINES OF EVIDENCE

***Mine Discharge Water*** is primarily from Morrison Fm (Ore Zone) and Overlying Dakota Sandstone Formation (Drained into Morrison Fm)



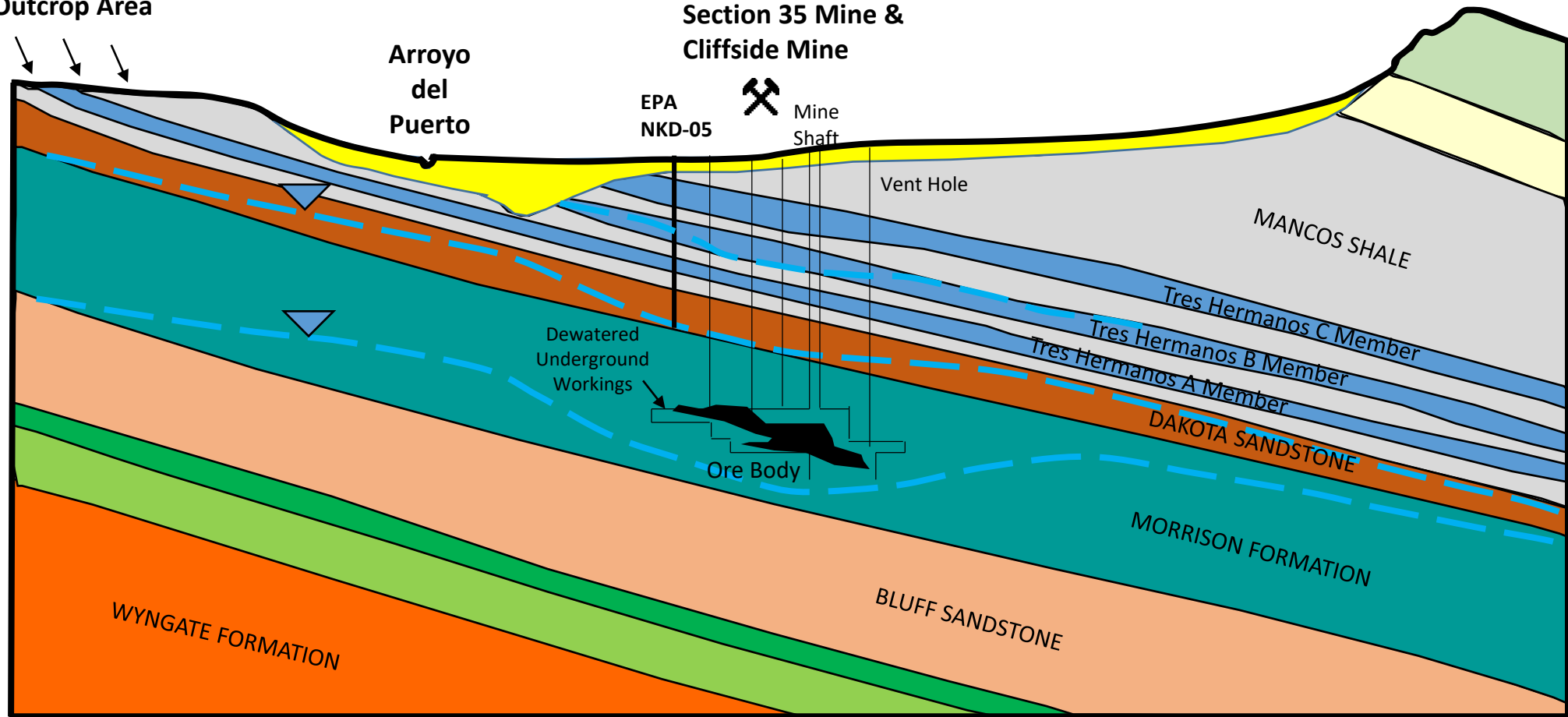
**B**  
South

# GENERALIZED CROSS SECTION B-B'

## AMBROSIA LAKE AREA

**B'**  
North

Ground Water Recharge  
in Outcrop Area



Modified from Kerr McGee Nuclear Corporation, 1980

Not to Scale



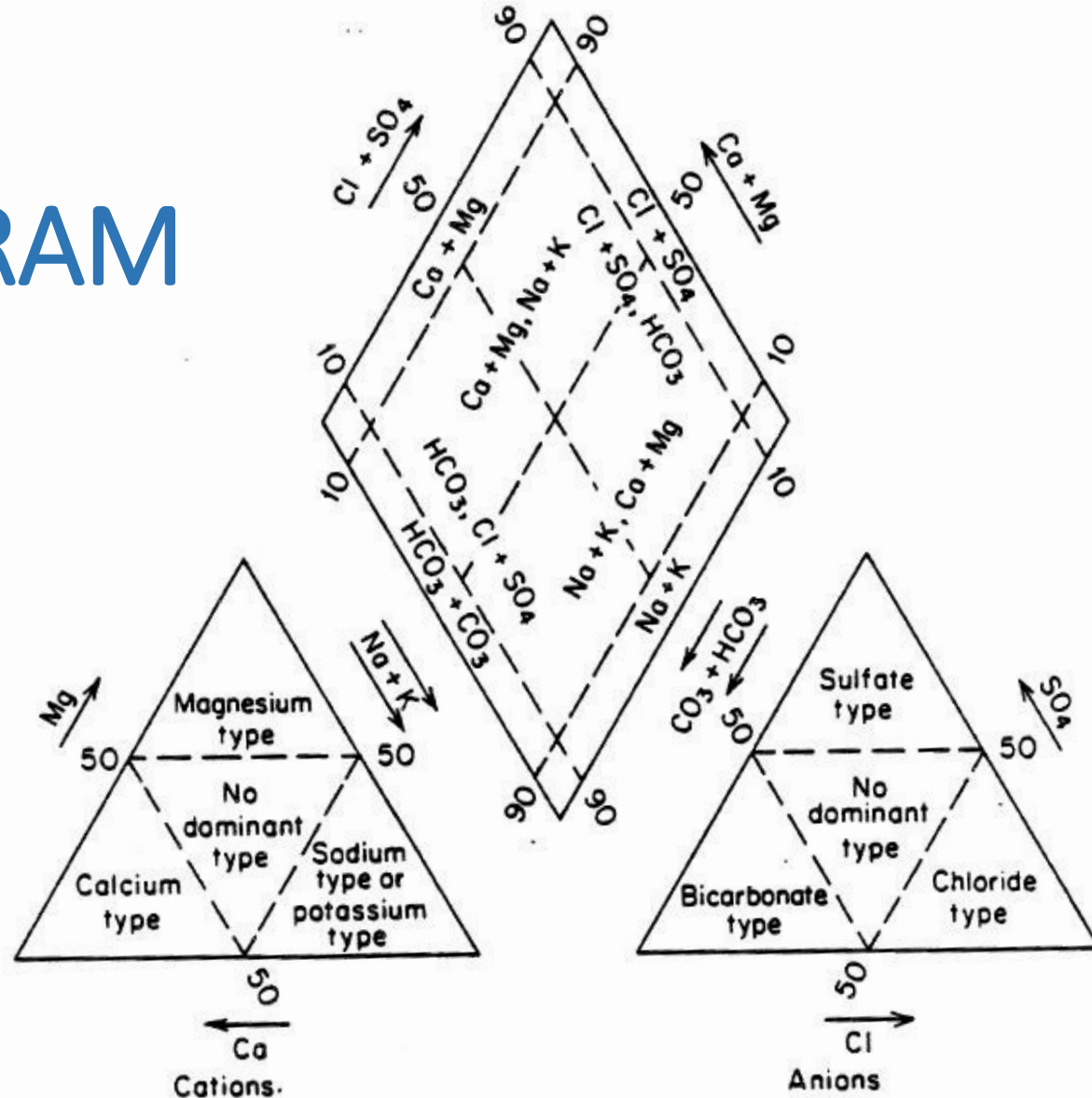
Estimated Water Level

Draft – For Discussion Purposes Only



# TRILINEAR DIAGRAM

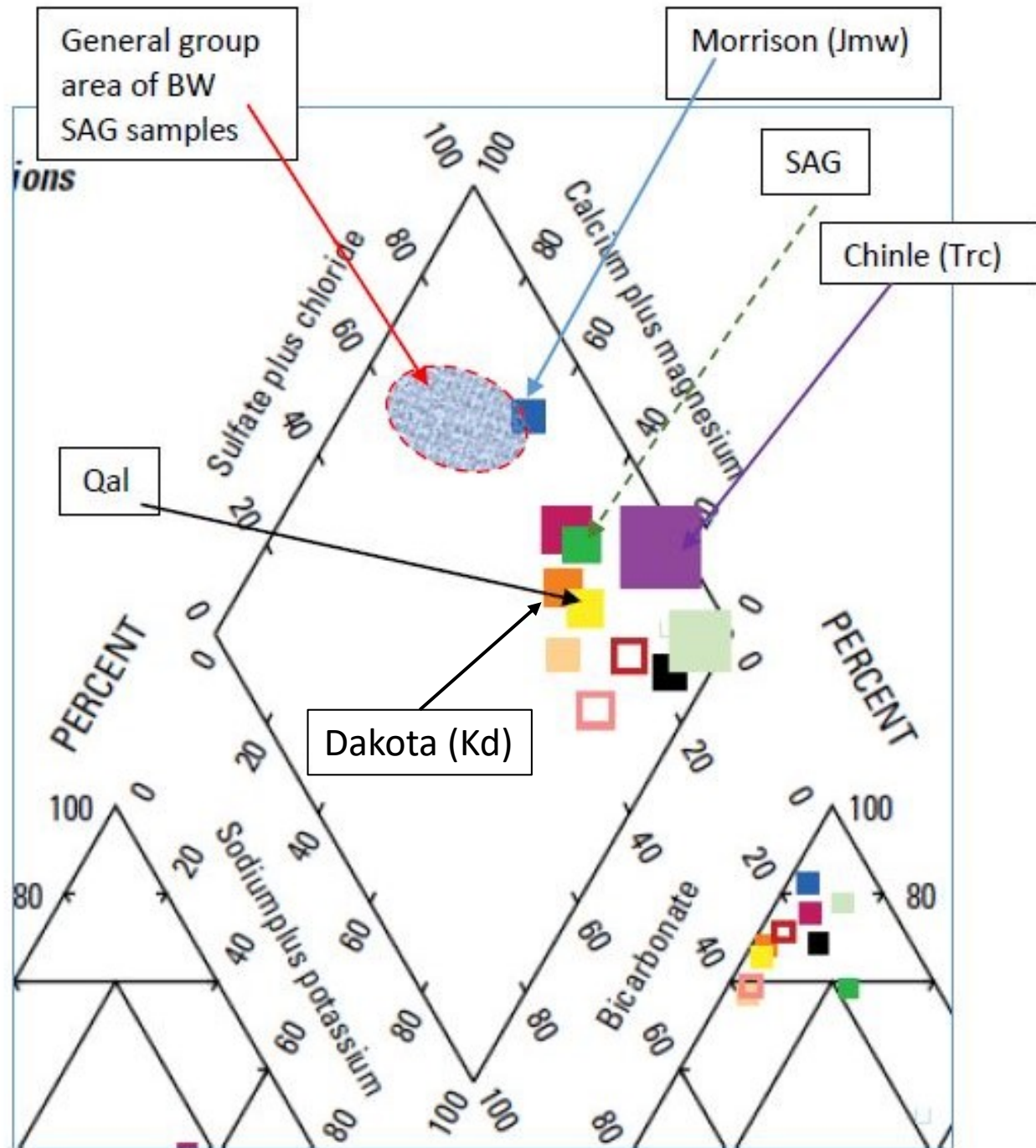
Major Ion Composition  
Defines Water Type



# USGS TRILINEAR (PIPER) DIAGRAM

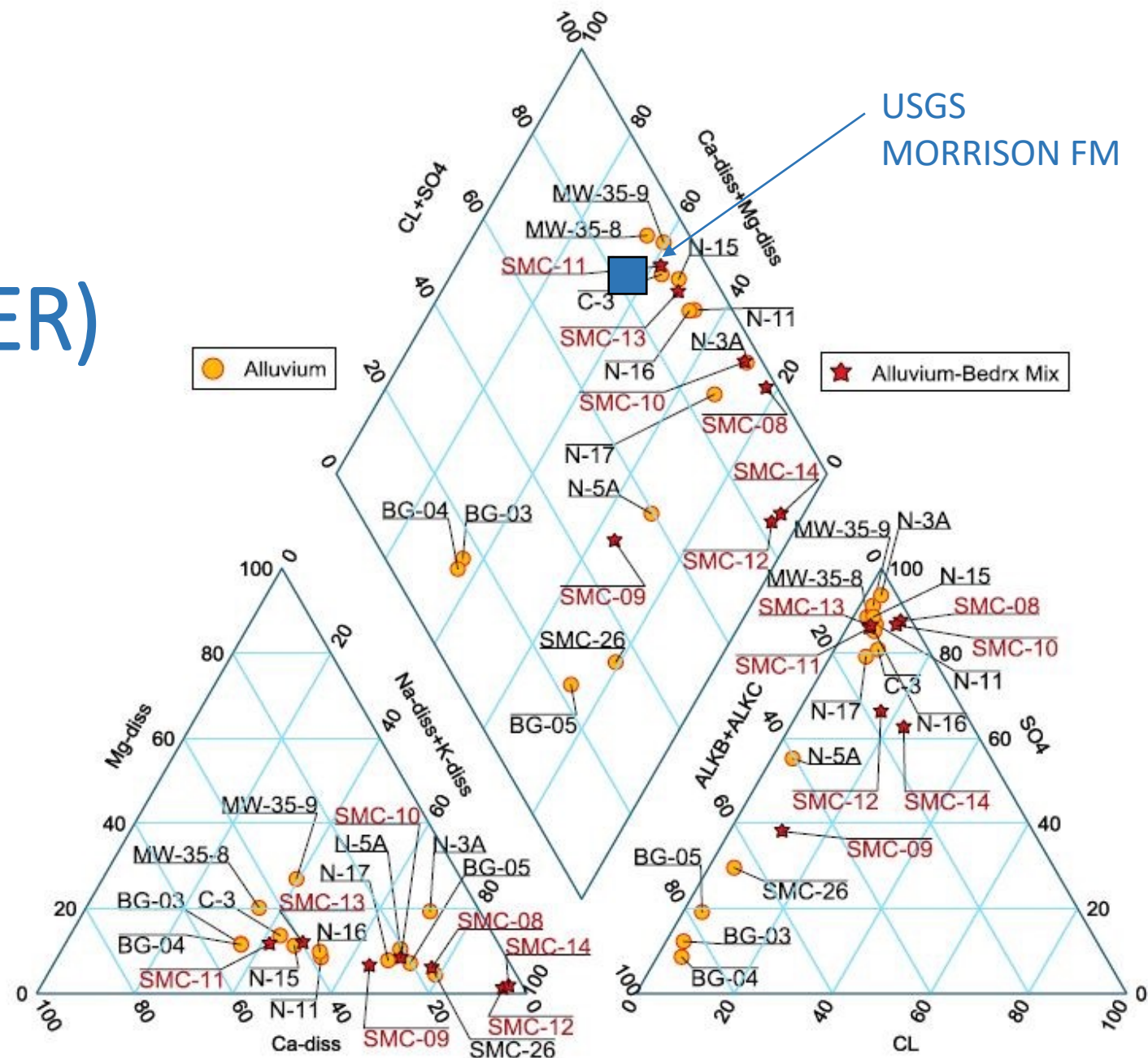
## Upper San Mateo Creek Basin Study

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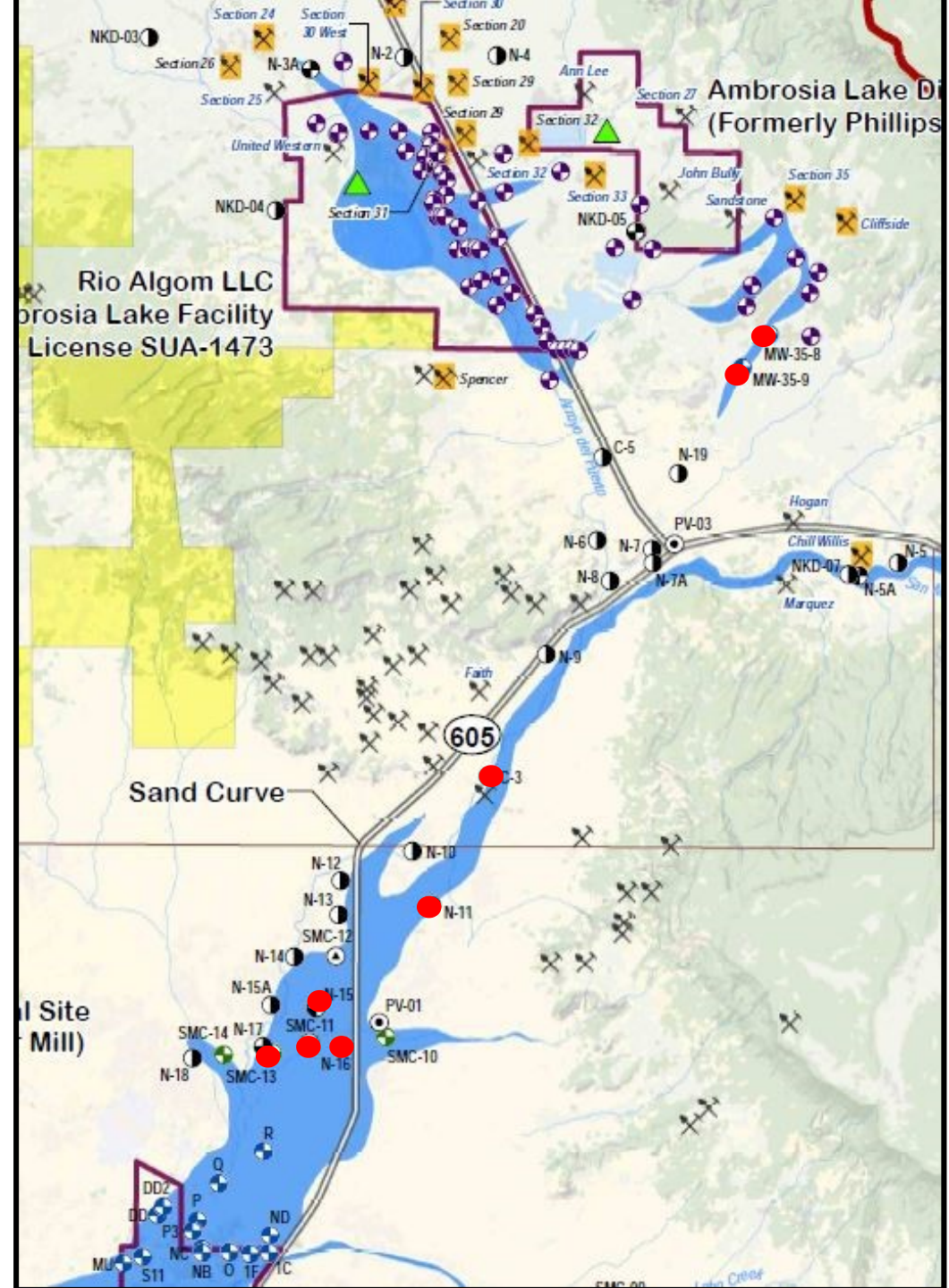




# EPA TRILINEAR (PIPER) DIAGRAM



# ALLUVIAL WATER WITH MORRISON FM MAJOR ION COMPOSITION



**Draft – For Discussion Purposes Only**

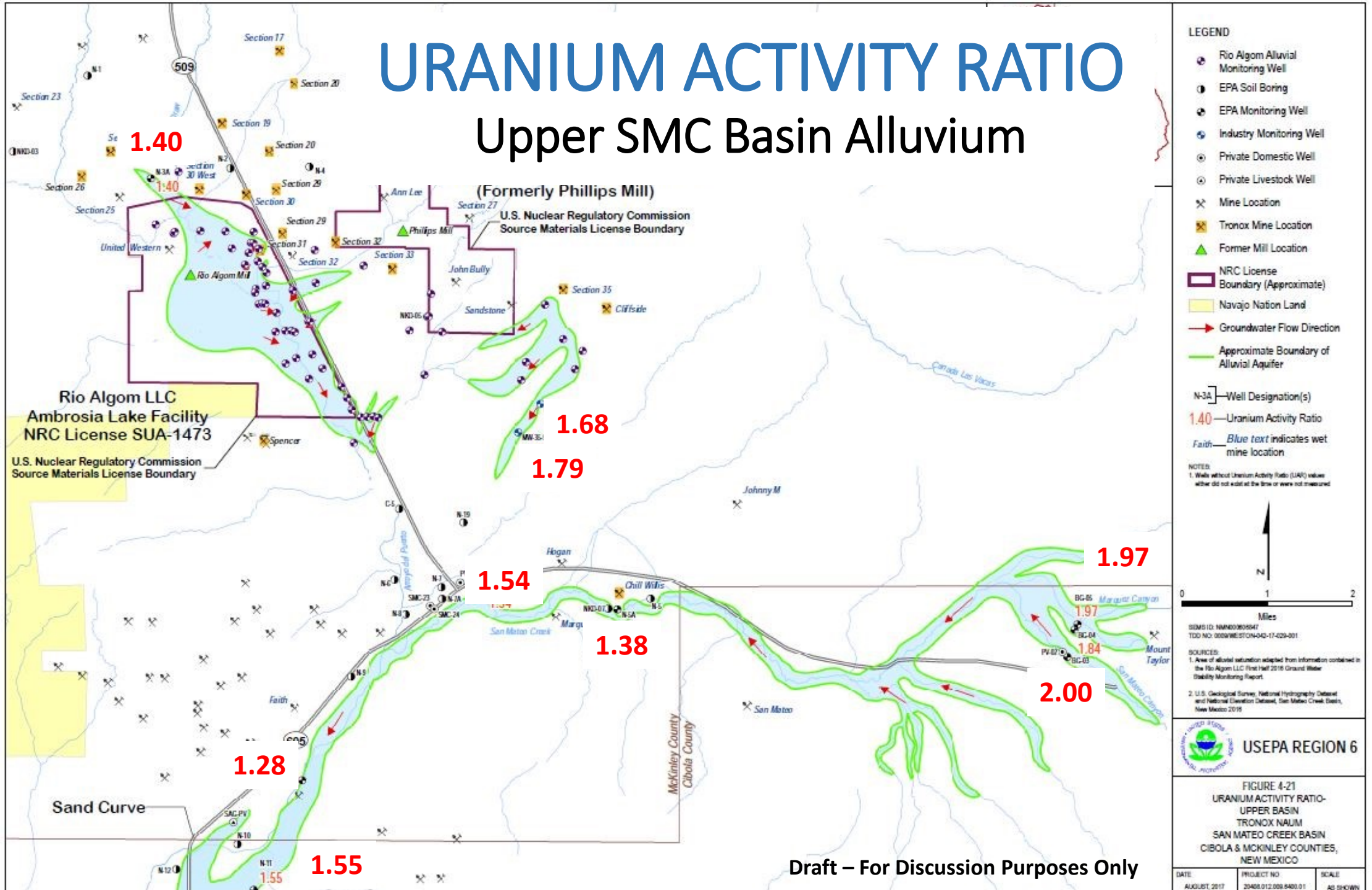


# URANIUM ACTIVITY RATIO (UAR)

- U-234/U-238 RATIO
- DISTINGUISH BETWEEN MILL/MINE URANIUM CONTAMINATION AND NATURALLY OCCURRING BACKGROUND
  - U-234 AND U-238 Reach Secular Equilibrium in Closed System (Rock)
    - U-234 Production from U-238 Decay = U-234 Loss through Decay
    - $UAR = 1.0$
  - U-234 Preferentially Released in Ground Water
    - Caused by Disruption of crystalline structure
    - Elevates UAR Values in most natural ground waters
- $UAR \text{ VALUES} > 1.5 = \text{BACKGROUND}$
- $UAR \text{ VALUES} < 1.35 = \text{URANIUM MINE OR MILL SOURCE}$

# URANIUM ACTIVITY RATIO

## Upper SMC Basin Alluvium



1.40

1.68

1.79

1.54

1.38

1.97

2.00

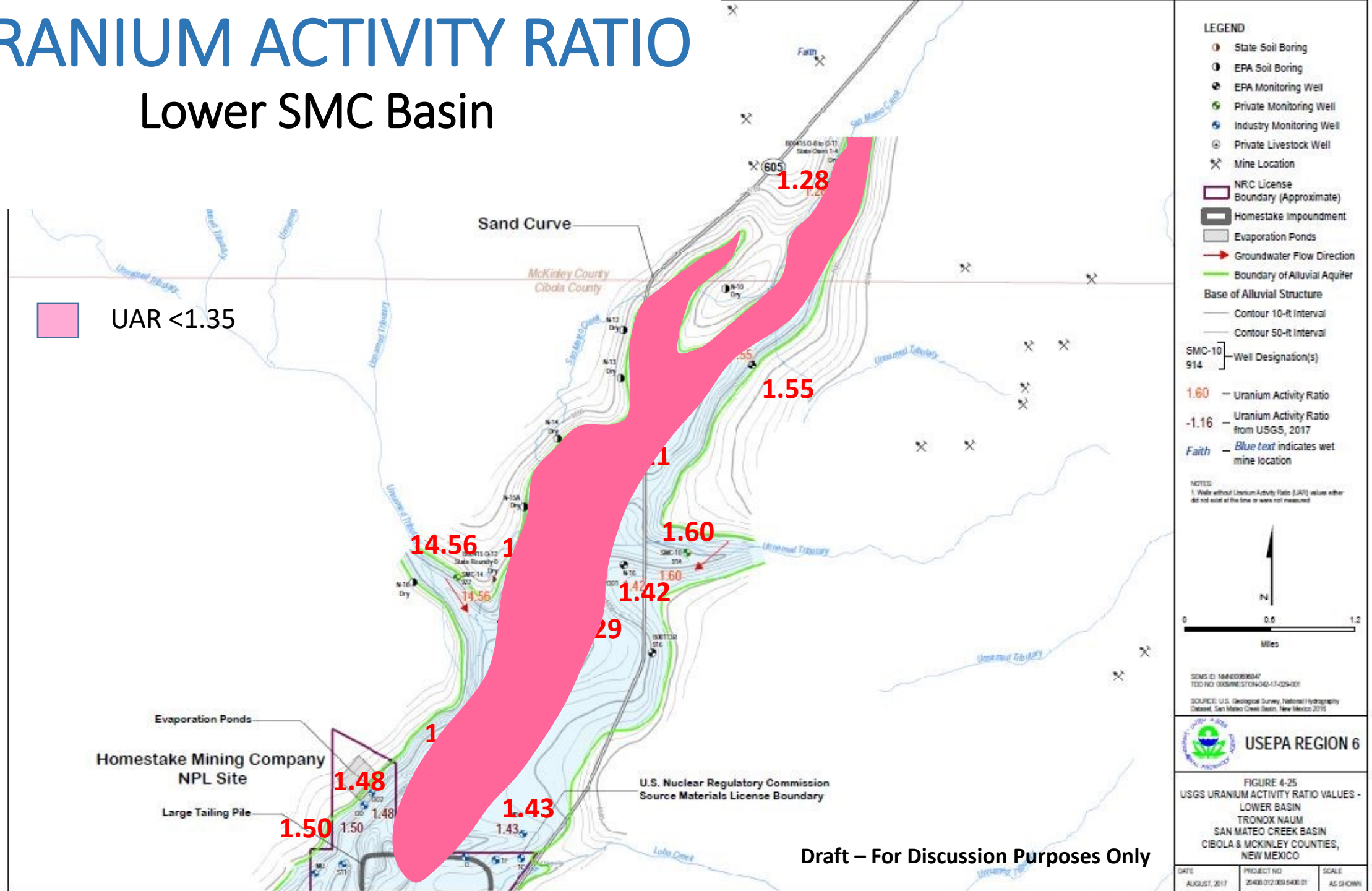
1.28

1.55



# URANIUM ACTIVITY RATIO

## Lower SMC Basin



# $\delta^{34}\text{S}$ ISOTOPE

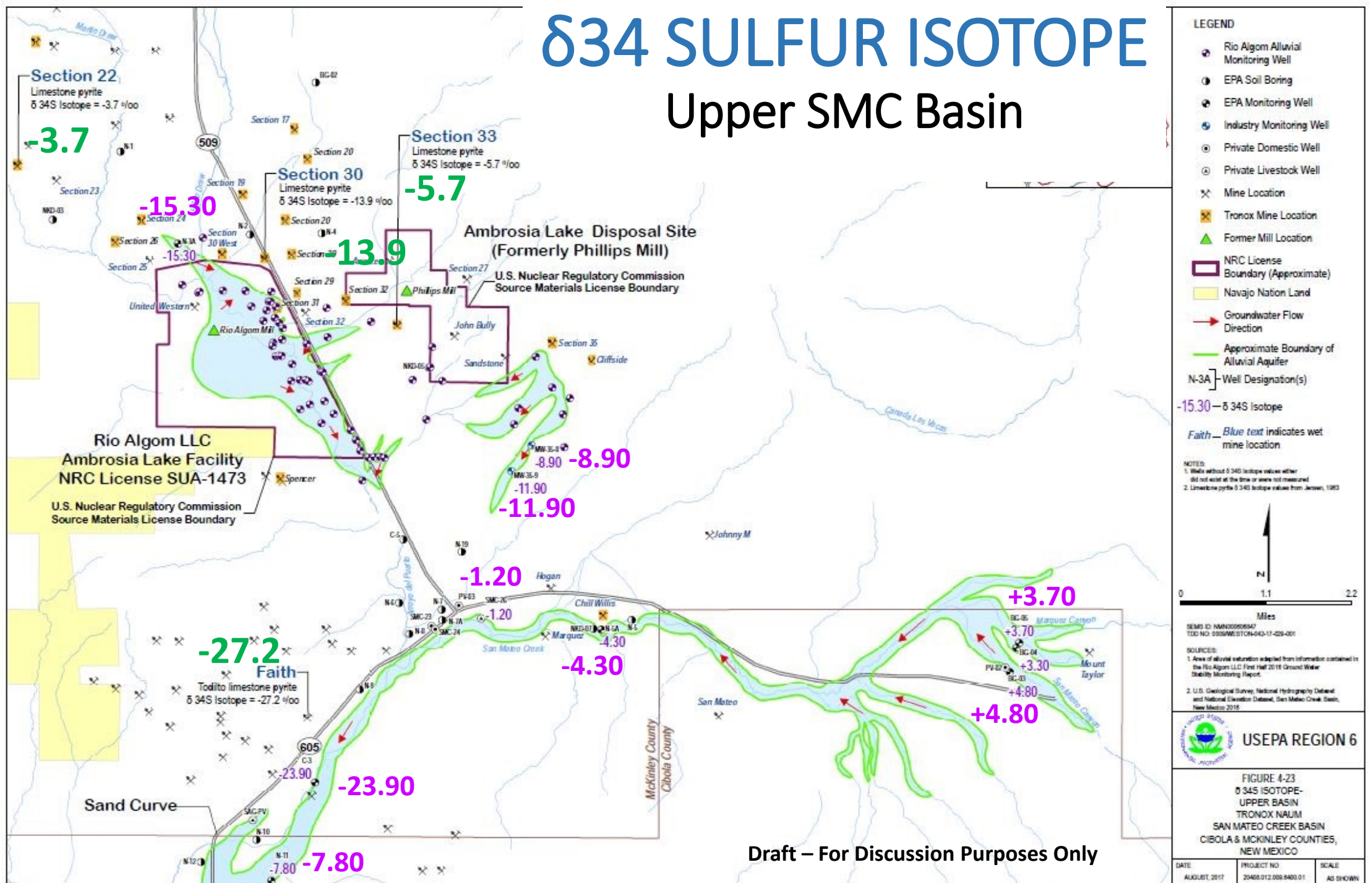
- ISOTOPIC COMPOSITION OF SULFUR ( $\delta^{34}\text{S}$ ) IS KNOWN
  - For Global, Regional and Local Sources
  - Sulfate Minerals (Gypsum, Anhydrite)
  - Sedimentary Sulfides (Pyrite)
- USED AS TRACER OR FINGERPRINT TO SOURCE SULFATE



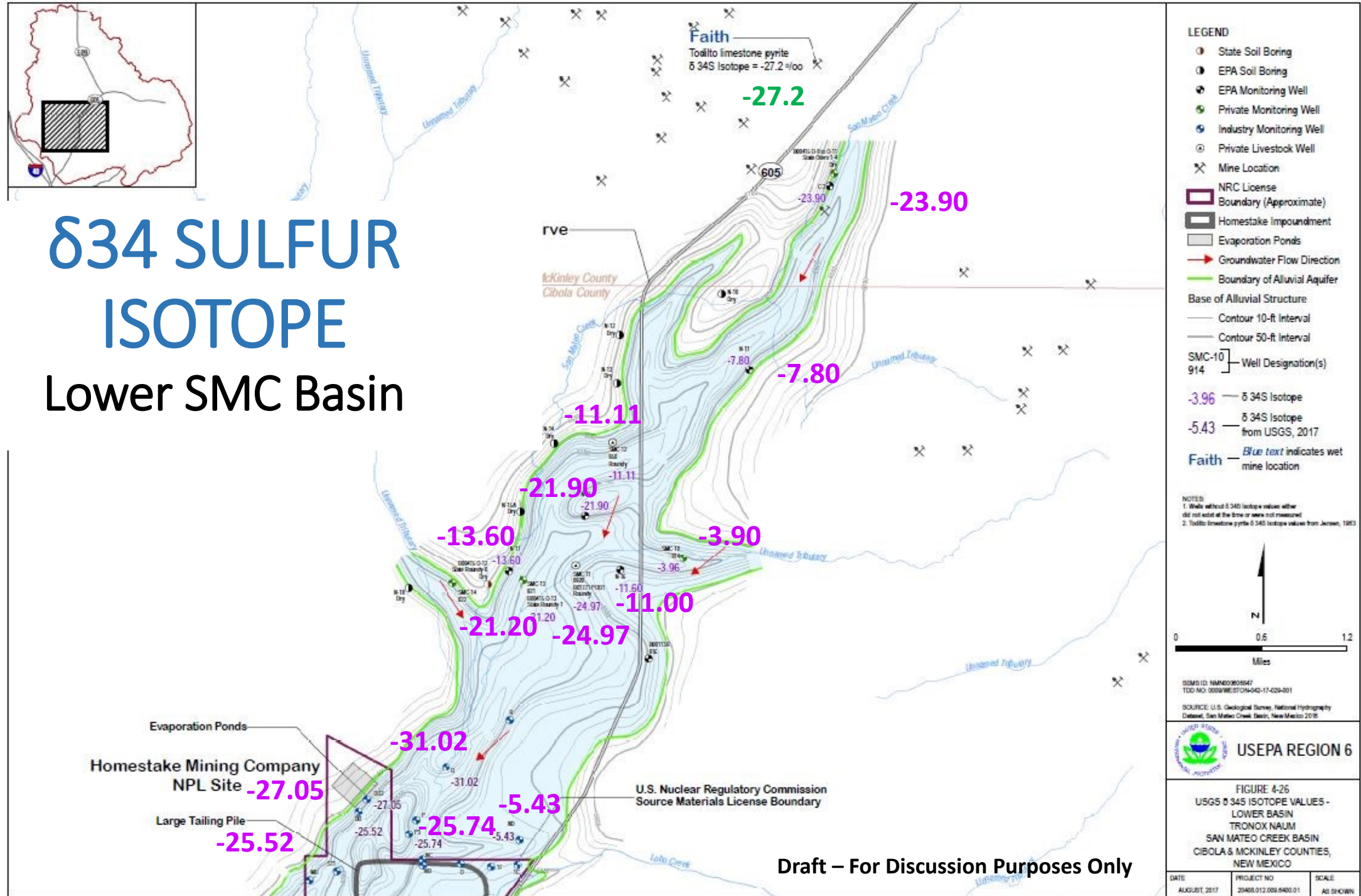


# $\delta^{34}\text{S}$ SULFUR ISOTOPE

## Upper SMC Basin

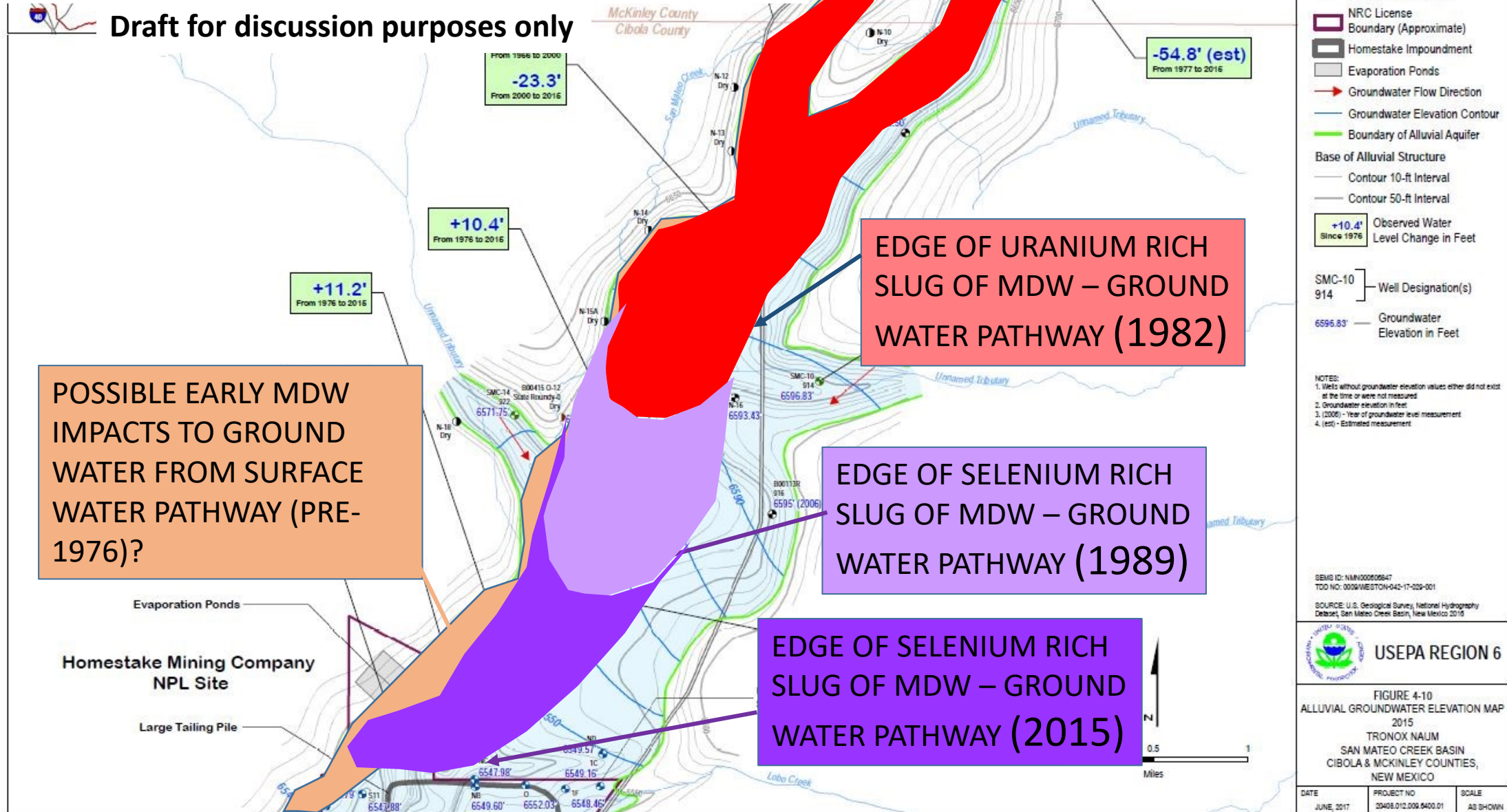


# $\delta^{34}\text{S}$ SULFUR ISOTOPE Lower SMC Basin





# CONCEPTUALIZED IMPACTS OF MINE DISCHARGE WATER



# QUESTIONS

